Railway Mechanical Engineer

Name Registered U. S. Patent Office

Founded in 1832 as the American Rail-Road Journal

With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, and Railway Master Mechanic.

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Editorial Contents for February, 1929

Volume 103 *No. 2*

Heavy 2-8-8-4 Type Locomotive for the Northern Pacific ..... Page 56
The largest locomotive ever built is equipped with a power-operated throttle, five syphons and many other unique mechanical features.

Highball Scott Dissertates on Advertising ..... Page 67
Our friend, the master mechanic, takes violent exceptions to some of the methods of presentation in technical advertisments.

B. & M. Centralized Freight Car Repairs at Concord, N. H. ..... Page 78
Good results are obtained by systematised repairs and a carefully worked out material handling system.

Paducah Repair Shop Operation Meets Expectations ..... Page 100
Mr. Lee Robinson, Shop Engineer, explains how these shops are laid out and tooled to give maximum output at a minimum cost of repairs.

EDITORIALS:
- Use the Packing Iron 53
- More Attention to Sanding Facilities 53
- Preventing Accidents Caused by Falls 53
- Gages Should Be Checked Periodically 54
- Changing Problems of Maintenance 54
- Co-operation Needed To Reduce Car Damage 55
- New Books 55

GENERAL:
- Heavy 2-8-8-4 Type Locomotive for the Northern Pacific 56
- Locomotive and Motor-Car Orders in 1928 ... 64
- Highball Scott Dissertates on Advertising ... 67
- The Characteristics of Injectors 72

CAR DEPARTMENT:
- B. & M. Centralized Freight Car Repairs at Concord, N. H. 78
- Decisions of Arbitration Cases 85
- Ballot on Brakes and Brake Equipment 86
- How To Reduce Bad Order Cars 87
- Painting and Handling Sash 91
- A Convenient Welding Booth 92
- Car Orders Placed During 1928 93

SHOP PRACTICE:
- Manufacturing and Gaging Taper Frame Bolts 95
- A Sturdy Tool Holder for Slotters 98
- One Use for a Left-Hand Drill 99
- Storage Rack for Steel Rods and Pipe 99
- Paducah Repair Shop Operation Meets Expectations 100
- A Convenient Shop Cabinet 107

READER'S PAGE:
- Gage for Checking Saddle Seats on Driving Boxes 108
- Wanted—Constructive Ideas 108

NEW DEVICES:
- Three Milling Machine Attachments 109
- Lincoln Safety Push-Button Control 110
- No. 35 Plain Grinding Machine 110
- Grinder for Sharpening Die-Head Chasers ... 111
- Effective Mask for the Railroad Shop 111
- Welding Gloves Not Affected by Heat 111
- Steel and Composition Car Flooring 112
- Combination Shear, Punch and Coper 113
- Rule Depth Gage for Small Holes 113

NEWS OF THE MONTH 114

Published on the first Thursday of every month by the Simmons-Boardman Publishing Company, 34 North Crystal Street, East Stroudsburg, Pa., and 30 Church Street, New York

SIMMONS-BOARDMAN PUBLISHING COMPANY, 30 CHURCH STREET, NEW YORK

Publishers also of Railway Age, Railway Engineering and Maintenance, Railway Electrical Engineer, Railway Signaling, Airway Age, Marine Engineering and Shipping Age, The Boilermaker, Locomotive Cyclopedia, Car Builder's Cyclopedia, and Railway Engineering and Maintenance Cyclopedia

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Request for change of address should reach the New York Office two weeks before the date of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, be sure to send us your old address as well as the new one.

Subscriptions, including the eight daily editions of the Railway Age published in June, in connection with the annual convention of the American Railway Association, Mechanical Division, payable in advance and postage free: United States, Canada and Mexico, $3.00 a year; foreign countries, not including daily editions of the Railway Age, $4.00.

The Railway Mechanical Engineer is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

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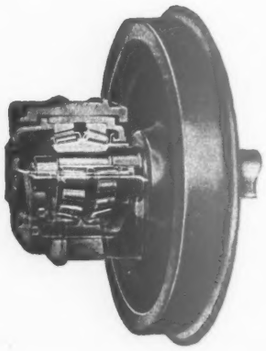

The way to great economies and other operating betterments is clearly shown by the success of Timken Bearings in car-journals.

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Railway Mechanical Engineer

Founded in 1832 as the American Rail-Road Journal

Vol. 103 February, 1929 No. 2

Use the Packing Iron

THE packing iron is one of the simplest of tools used on a railroad, but that is no reason for belittling its value. This sentiment is echoed in the following instructions recently given by the superintendent of a car department to his staff, which needs no further comment: "Again I want to impress upon all, the importance of using the packing iron to set up packing. Of course, if a box shows indications of being dry lubrication should be added. But if the packing has plenty of oil, and is only disarranged, the packing iron will do more to off-set the tendency of a box to run hot than anything else."

More Attention to Sanding Facilities

THE quantity of sand used for locomotive purposes and the expense of handling it is not always appreciated and given due consideration in the lay-out of engine terminal facilities. For example, at one terminal, the location of the wet sand storage 100 ft. from where it is would permit unloading sand from cars with the gantry crane used for ash handling and almost totally eliminate the high labor cost of hand shoveling now necessary. Some interesting information developed at the last convention of the International Railway Fuel Association indicates that, while compressed air provides one of the most convenient means of elevating sand to storage bins, it is not necessarily the most economical. With compressed air available at every terminal of importance, it is very easy to adapt this method to almost every kind of operation requiring power, and the cost of compressed air is often overlooked.

The best method of drying sand also is somewhat open to question, one road reporting an average cost of 73 cents per ton of sand dried with a coal-fired stove as compared with 50 cents per ton with a steam dryer. This advantage in favor of the steam dryer was augmented by the fact that its repair cost was only $50 per annum as compared to $50 per annum for stove maintenance. The committee recommended the application of steam dryers where practicable on account of the "lower cost per ton of sand dried, greater capacity per hour, reduction in labor, uniform rate of drying and elimination of the fire hazard."

In the type of gravity sand-handling plant now provided at many large modern terminals, the wet sand is unloaded in a track hopper and hoisted by conveyor to overhead wet storage bins built integral with the main coaling station. The sand is then allowed to flow by gravity to dryers and dry sand bins, from which suitable sand spouts and valves conduct it to the locomotive sand domes.

Preventing Accidents Caused by Falls

ACCIDENT bulletin No. 96, issued by the Interstate Commerce Commission, indicates that during 1927, on all roads, 51 deaths and 6.693 reportable injuries were caused by falls of employees in non-train casualties. That a substantial proportion of these casualties were chargeable to falls from elevations such as temporary scaffolds, cannot be doubted and, in discussing this subject at the National Safety Council meeting last October, Z. B. Claypool, assistant director of accident prevention of the St. Louis-San Francisco, made the following interesting comment.

"A great many of these falls could be eliminated by adopting the policy of moving the job to a permanent scaffold instead of taking a temporary scaffold to the job. For example, on the car-department repair track, where rebuilding is done, the work can be specialized and handled by the progressive system in much the same manner as an automobile is built. Starting at the head end of the track car men apply their sills, the car then going to a station equipped with permanent scaffolds necessary for erection of the superstructure, and so on down the line until the car is rebuilt by the time it reaches the opposite end of the track from where the first operations began. The car men have remained in fixed locations and performed their work in less time and with greater safety as the work and material was moved to them. We have adjustable permanent scaffolds in our coach repair shops and coach paint shops. Why not on our freight repair tracks?"

Where temporary scaffolds must be employed, it is a distinct responsibility of the foreman, by instruction, example and discipline if necessary, to make sure that sufficient care and time are taken in the erection of temporary scaffolds to afford reasonable assurance that they will not cause falls, resulting in loss of time by employees, loss of service by railroads and expense all around.

Falls due to stepping into enginehouse cinder pits, air-

and steam-line hose-connection pits in train and repair yards, can be minimized by the provision of suitable railings, covers, etc. Numerous falls occur due to stumbling over scrap, misplaced material, etc., and not only indicate carelessness on the part of employees but reflect on the supervision which permits disorderly conditions about repair shops and yards. Mr. Claypool's closing suggestions for the reduction of accidents due to falls in the mechanical department were: "First—by providing sufficient and efficient scaffolds; second—by safeguarding openings; and third—by clean housekeeping." There is absolutely nothing new about these suggestions, but the fact that 51 persons were killed and 6,693 injured in a year, largely due to disregard of these precautions, indicates that they need still further emphasis and attention.

Gages Should Be Checked Periodically

IT has often been said in the spirit of criticism against railroad maintenance methods, that one-eighth inch was considered a close working tolerance for locomotive repairs. Perhaps this criticism was justified five years ago, but in the main, it does not hold true today. The railroads have realized that if locomotives are to be operated with a minimum of running repairs between shopping periods, the parts must be fitted to close tolerances. Elsewhere in this issue appears an article on the "Manufacture and Gaging of Taper Frame Bolts" in which the author describes the design and use of several types of close tolerance gages. Gages of this type are made either over master gages, or by the use of micrometers and other accurate measuring instruments. The finished gages are subjected to hard usage in railroad shops, which in time will destroy their accuracy and counteract the fundamental object of tolerance gages. Thus, it is essential that all gages be subjected to periodical inspection for accuracy. A record should be kept of each gage, which would show when it was made, its purpose, its correct dimensions, how often it should be inspected, the results of each inspection, and the number of times the gage has been returned to the toolroom for repairs. If no attempt is made to check gages at regular intervals, it is only a question of time before they become a liability instead of an asset in the general scheme of accurate repairs.

The Changing Problem of Maintenance

MAINTENANCE as applied to motive power and rolling stock is a repair program designed to keep equipment in the best possible condition for service. The standards of maintenance have changed and the manner in which the change has taken place is of great importance, not so much in the light of past accomplishments as in the possibility that an analysis of the changes may show the way to greater improvement in the future.

It is not necessary to go very far back into the past to appreciate that the problem of keeping locomotives in serviceable condition was looked upon as one of giving them a thorough overhauling at definite periods and making the running repairs necessary to keep them on the road between these overhaul periods. Each class of locomotives was assigned a mileage which it was expected would be run out before the next general shopping. In many cases, barring accidents of course, locomotives were forced into the shop for general repairs before the mileage was run out. Where this was true the condition could usually be attributed to a lack of proper terminal inspection and running repairs. Then, about six years ago, the operating departments on several roads inaugurated the practice of extended runs and with this practice changes in maintenance methods began to take place. More rigid inspection and periodical running repairs were found to be the solution of the problem of preventing serious engine failures on long runs. The results were so satisfactory in most cases that an extended application of the general idea of better terminal maintenance has resulted in a marked improvement in locomotive performance—a great increase in the mileage per engine failure and an increase in the percentage of actual locomotive mileage to assigned mileage.

Without going into detailed figures it may be said that the maintenance standards of today and the methods that have made these standards possible have resulted in an improvement in locomotive condition, a reduction in the number of classified repairs and, still more important, a reduction in locomotive repair costs per mile.

Outside of the field of motive power a striking example of the value of good maintenance may be seen in the experience the railroads have had with the modern rail motor car. The maintenance problem with this class of equipment seems to be one of parts replacement and running repairs. The service records show that many of these cars have run from 200,000 to 300,000 miles without general overhauling and, in some cases, with a reliability factor of better than 99 per cent.

To what may this improvement in mechanical-department conditions be attributed—to organization, to methods or to facilities? The answer would undoubtedly point to a combination of all three factors and yet the industries have demonstrated that, given modern facilities, a good organization can develop methods that will accomplish the seemingly impossible. The progress made up to this time is only an indication of the greater progress which must be made in the future and the possibilities of future improvement in the maintenance problem seem to point to the necessity of taking advantage to the fullest extent of the modern facilities that are now available. There are approximately 325 locomotive shops in the United States. How many of them may be considered modern? How many of them can overhaul a modern heavy locomotive in less than ten days? A few of them are doing it now. There are about 3,000 engine terminals in this country. Are those on your road equipped to keep a locomotive away from the back shop until it has run out its assigned mileage? Of the more than 1,200 car-repair shops and yards in this country, can it be said that they are capable of maintaining passenger and freight cars at maximum serviceability with minimum expense?

Today's maintenance problem is one of keeping equipment on the road as long as it will render satisfactory service without serious delay due to mechanical failure. The heavy repair shop builds service life into a car or a locomotive. Modern facilities and methods in this shop will return equipment to revenue service

with a minimum of lost time. Modern car and locomotive terminal facilities will keep equipment on the road between general shoppings with a minimum of delay caused by mechanical failure. A comprehensive program for modernizing facilities is a most important factor in the maintenance problem and whether the curve of future progress will go up or down will depend, in part at least, on the manner in which such a program is developed right now.

Co-operation Needed to Reduce Car Damage

IN a recent paper before the Car Foremen's Association of Chicago, which is abstracted elsewhere in this issue, K. F. Nystrom, superintendent of the car department of the Chicago, Milwaukee, St. Paul & Pacific, said: "We should keep in mind that every time a car is damaged by rough handling, it throws an extra burden of expense on the car department and is charged to our maintenance accounts, and when considered for a period of a year, we could overhaul many hundreds of cars with money spent in repairing damaged equipment caused by the carelessness of switching crews. The remedy, of course, lies with the operating department, but unless the car department supervisors make it a point to report all cases of cars damaged to the superintendent, we can hardly expect an improvement. We find the superintendents quite willing and anxious to co-operate but, without the required information supplied by the car department to permit taking disciplinary action with the train crews responsible, we can hardly expect to obtain results."

There is no question that more unnecessary damage to equipment occurs than is commonly appreciated. Everyone is familiar with the "constant bombarding" caused by the rough handling of cars in freight yards. It is generally conceded that when impact speeds exceed two miles an hour, the lading in cars equipped with spring draft gears begins to slide and damage results. At less than three miles an hour, damage to the car itself occurs. Low-capacity friction draft gears in good condition offer protection only up to impact speeds of about four miles an hour.

Damage to cars caused by excessive switching speeds is often unseen, particularly in its early stages and, on account of this fact, car department officers themselves do not always realize the seriousness of the cumulative effects. They have a distinct responsibility, however, to bring all cases of rough handling and excessive switching speeds to the attention of the proper officer in the operating department. In one terminal the rough handling situation was attacked vigorously, and by taking steps to have all cases reported promptly by the train yard car inspectors to the car foreman and then to the superintendent, the amount of equipment damage was reduced from 200 to 90 cars a month, with every indication that the latter figure would be still further reduced. Switching crews are between two fires, namely, an urge for the rapid handling of cars and a fear of being charged with rough handling due to excessive speeds, but experience has shown that crews working at high speed and somewhat carelessly do not get as much done in the long run as those working more moderately, studying their operations in advance and making no false moves.

Car foremen can also prevent damage to equipment by greater attention to the loading or unloading open top cars by such machines as locomotive cranes equipped with magnets and clam shells. The railways spend large amounts of money annually in renewing the top side plates, side planks, floors and drop doors in this equipment. At the meeting referred to, one car department supervisor said: "We are handling a quantity of gravel and sand in open top cars. Contractors move from point to point as work progresses and it is here we are finding a new avenue of damage. The ever-hurried operator, knocking off brake staffs, dropping buckets through drop doors or swinging too low, causes damage to side or end planking. We all have this same condition to contend with, and attempting to collect damages from contractors is not always easy. Our road has made a successful reduction in these cases by holding each car foreman responsible for policing his district at points where cars are unloaded. Contractors are more careful when they know that they will be presented with bills for car damage." Car-department supervisors can perform a real service for their railroads by constantly being on the alert to notice all instances of the abuse of equipment and reporting to the proper authority so that car damage can be minimized.

New Books

PROCEEDINGS OF THE AIR BRAKE ASSOCIATION. *Published by the Air Brake Association, 165 Broadway, New York. 382 pages, illustrated. 6 in. by 8-1/2 in. Bound in black leather.*

The book containing the proceedings of the thirty-fifth annual convention of the Air Brake Association, which was held at Detroit, Mich., May 1 to 4, 1928, inclusive, is similar in size, appearance and make-up to its predecessors. A valuable feature that has been incorporated in this book for many years is a list of the subjects of papers and committee reports that have been presented before the association since its first convention in 1894. The subjects discussed at the thirty-fifth annual convention include: Triple-valve union gaskets —rubber vs. leather; standardization of the braking power of freight cars; yard air plants; maintenance of steam-driven air compressors; What is the best material for air brake and air signal piping; Relation of the air brake to slack action and shocks in trains; Exclusion of dirt and moisture from passenger car brake cylinders; Recommended practice, and power brakes for automobiles.

PROCEEDINGS OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION. *Published by the International Railway Fuel Association, 313 Railway Exchange, Chicago. 564 pages, illustrated. 6 in. by 9 in. Flexible red leather binding.*

Besides the regular reports of committees on Diesel locomotives; Firing practice; Front-ends, grates and ashpans; Fuel economy; Locomotive fuel stations, etc., the proceedings of the twentieth annual convention of the International Railway Fuel Association held at Chicago, May 8 to 11, 1928, records in full the several individual papers and discussions on some economic aspects of fuel conservation, by J. H. Parmalee; Roller bearings in relation to fuel economy, by K. F. Nystrom; Some aspects of the trend of locomotive fuel economy, by W. L. Bean; Possibilities in future locomotive design, by W. E. Woodard; Locomotive of today and the future as a factor in fuel economy, by A. W. Bruce, and Combustion in the locomotive boiler, by Lawford H. Fry.

Northern Pacific single expansion articulated locomotive built by the American Locomotive Company

Heavy 2-8-8-4 Type Locomotive for the Northern Pacific

Weighs 1,116,000 lb.—Overall length is 124 ft. 11 5-8 in.—Develops combined tractive force of 153,300 lb.

THE Northern Pacific recently received a single-expansion, articulated 2-8-8-4 type locomotive from the American Locomotive Company, which is the largest locomotive ever built.

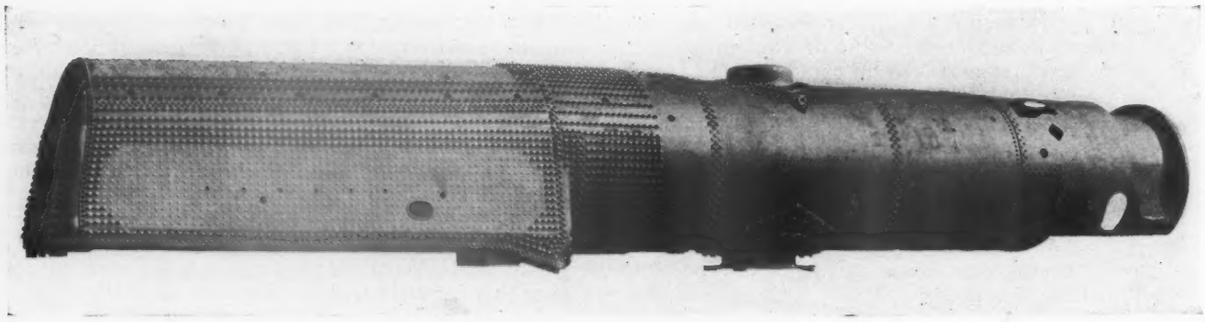
The total weight of this locomotive, which is named the "Yellowstone" type, on the Northern Pacific, is 1,116,000 lb., of which 715,000 lb. is the weight of the engine and 401,000 lb., the weight of the tender. Of the engine weight, 554,000 lb. is carried on the drivers, 45,500 lb. on the engine truck and 115,500 lb. on the trailer truck. It develops a tractive force at 70 per cent cut-off of 139,900 lb. and, with the additional tractive force of the booster at starting of 13,400 lb., gives a combined tractive force of 153,300 lb.

All four cylinders have the same diameter and stroke, 26 in. by 32 in., and the boiler (believed to be the largest steam locomotive boiler in the world) operates at a pressure of 250 lb. The driving wheels are 63 in. in diameter. The factor of adhesion for the locomotive is 3.94. The overall length between couplers, engine and tender, is 124 ft. 11⅝ in.

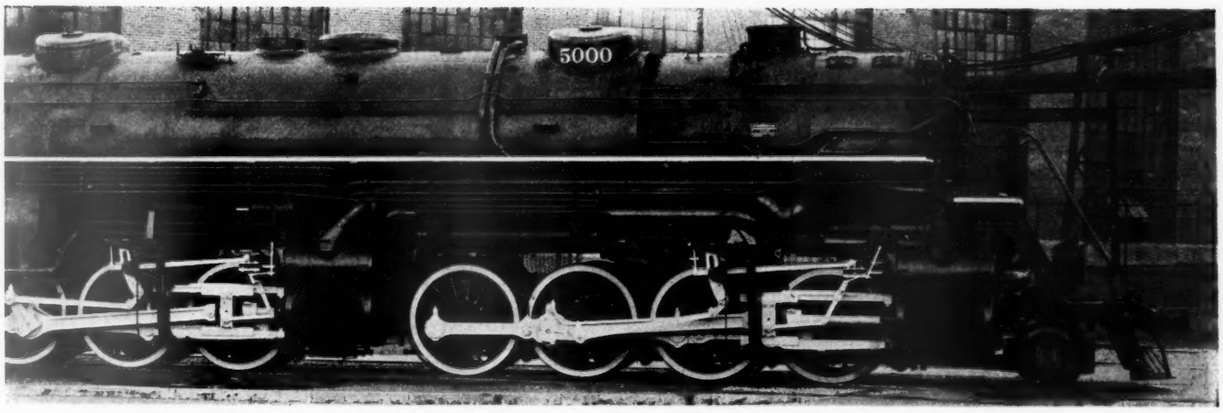
The extreme weight and overall length of this locomotive was due to complications encountered in the design of the firebox and boiler. The railroad desired to use eastern Montana sub-bituminous coal from an open-pit mine, owned by the railroad company at Colstrip, Mont. This sub-bituminous coal, while comparatively low in heat units, burns freely. The coal from this district, as received from the mine, varies between 24.6 and 30 per cent moisture, 11.9 and 14 per cent ash, with a heating value of from 6,208 to about 7,000 B.t.u. When dried, the heating value is increased to about 10,000 B.t.u. In order to obtain the required boiler horsepower from the heat developed by this coal, it was necessary to design the largest firebox and boiler ever applied to a steam locomotive.

Boiler Weighs 165,000 Lb.

This locomotive is equipped with a conical boiler built for a working pressure of 250 lb. per sq. in. The



The largest locomotive boiler in the world—Total evaporative heating surface, 7,673 sq. ft.—Grate area, 182 sq. ft.



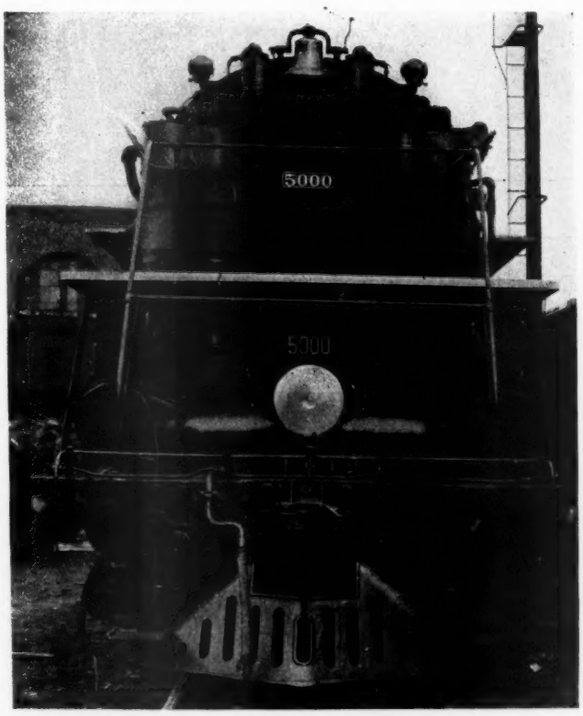
boiler is built with a factor of safety of 4.5. The grate area is 182 sq. ft., the total evaporating heating surface is 7,673 sq. ft. and the total superheating surface is 3,219 sq. ft. The estimated weight of the boiler alone is 165,000 lb. More than 20,000 holes were drilled in the boiler during its construction. It is equipped with five Nicholson Thermic syphons and there are 5,153 staybolts and 2,527 welded sleeves used in the firebox assembly.

The total length of the boiler is 63 ft. 8¾ in., while the firebox and combustion chamber combined are 28 ft. 6⅝ in. long. At the front end the boiler has an inside diameter of 103¼ in. and at the throat connection, an outside diameter of 110¼ in. Flange steel, having a tensile strength of from 55,000 to 65,000 lb. per square inch, and firebox steel, with a tensile strength of from 52,000 to 62,000 lb. per square inch, were used throughout. These plates have a total weight of 111,440 lb. The firebox has a length inside the sheets of 266⅛ in. and a width of 114¼ in. with a water space at the front of 7 in., at the back, 6 in., and at the sides, 6 in. The combustion chamber has a length of 72½ in. The inside firebox is in three sheets, the crown and side sheets being joined by arc welding. These sheets are also welded to the inside throat sheet and the one-piece combustion chamber is welded to the crown and inside throat sheet. Three of the five syphons are located in the firebox and two in the combustion chamber.

Coal is fed to the firebox with a standard Type B stoker, guaranteed to deliver 40,000 lb. of coal per hour. The ash pan has a Wilson bottom, with the railroad company's standard dumping arrangement.

The unusual length of the grates—22 ft. 3 in.—made it necessary to provide some additional means for manipulating a rake in the firebox, when cleaning the grate, other than through the fire door. Two 9-in. by 14-in. openings, located on opposite sides of the firebox, are provided to meet this exigency. They are located about 16 ft. from the rear of the firebox, so that the fire cleaner is able to rake any part of the grate area from the fire door or either of the two side openings, with the ordinary style of fire-hook. Folding platforms are located underneath each of the side firebox openings.

The firebox is supported at three points on each side, one under the front mud ring, one under the rear mud ring, and one near the middle at each side of the mud ring. All of these supports are of the sliding plate type and are fitted with renewable liners. Owing to the width of the box, the middle supports are attached to a steel cross-member of deep box section which extends across under the grate from one side of the mud ring to the other and forms the ridge separation between the front and rear hoppers of the ash pan. The supports under the rear of the mud ring are directly over the lateral centering and bearing device by which a portion of the weight at the rear end of the frame is transmitted to the rear end of the four-wheel trailing truck.

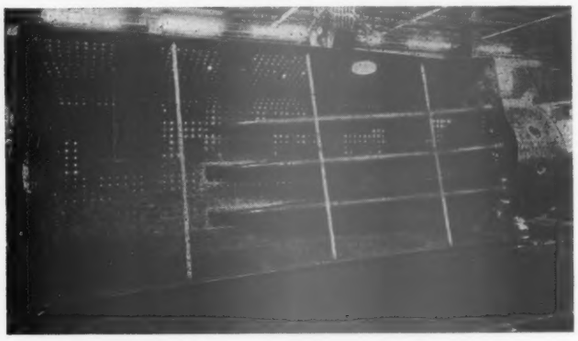


Front view of a Northern Pacific locomotive

The construction of the smokebox for this boiler entailed the formation of cutouts in the plate at the front end to accommodate the Coffin feedwater heater, which was applied. In building this part of the boiler, accuracy was essential so that when the heater was dropped in place, it would fit perfectly with ⅛-in. clearance to allow for expansion. The smokebox has a length of 146½ in. and a diameter of 106 1/16 in. and is made of ⅝-in. plate.

The Coffin feedwater heater installed on this locomotive, consists of

two size B heaters welded together, so as to form the same uniformity of steam passage as in the single size B unit, but with double its heat transfer capacity. No changes were made in the design of the castings, tube spacers, hand hole frames, etc. It is said that this heater has the largest amount of heating surface of any feed-water heater ever placed on a steam locomotive. Two

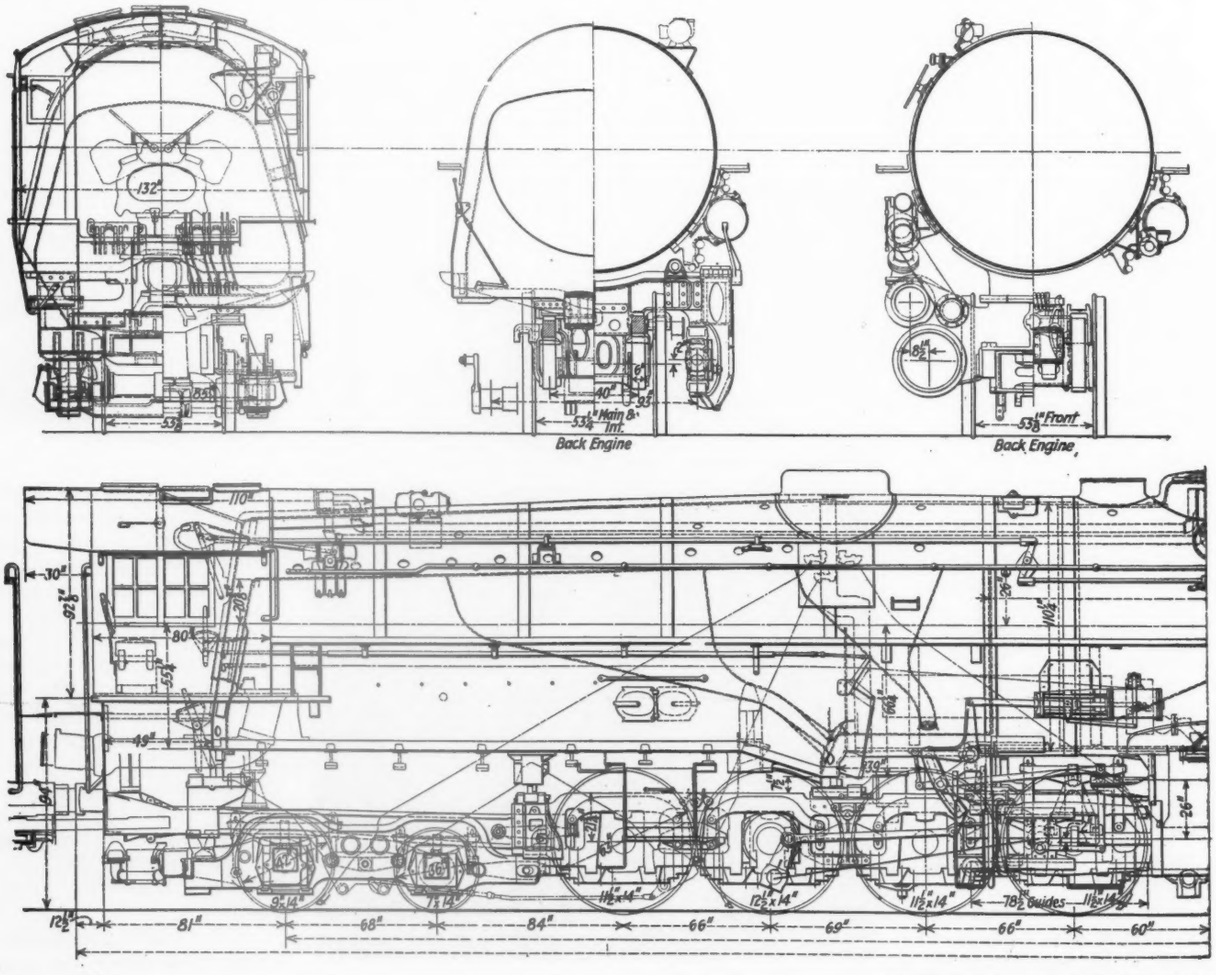


Inside of the firebox showing the location of the five syphons

standard Coffin centrifugal pumps, having a combined capacity of 100,000 lb. of water per hour, are located one on the right and one on the left side of the locomotive just back of the rear drivers. Separate control is provided for each pump. With this arrangement, it will be possible to operate one pump a large part of the time at maximum capacity, and the other pump may be used only to provide for peak-load conditions and to

Table of Dimensions, Weights and Proportions of the Northern Pacific Single-Expansion Articulated Locomotive

Railroad	Northern Pacific
Type of locomotive	2-8-8-4
Service	Freight
Cylinders, diameter and stroke	4—26 in. by 32 in
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7½ in.
Outside lap	1⅜ in.
Exhaust clearance	Line and line
Lead in full gear	3/16 in.
Maximum cut-off in full gear, per cent	70
Weights in working order:	
On drivers	554,000 lb.
On front truck	45,500 lb.
On trailer truck, front axle	55,000 lb.
On trailer truck, rear axle	60,500 lb.
Total engine	715,000 lb.
Tender	401,000 lb.
Total engine and tender	1,116,000 lb.
Wheel bases:	
Driving	44 ft. 6 in.
Rigid	16 ft. 9 in.
Total engine	66 ft. 8 in.
Total engine and tender	99 ft. 8 in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	33 in.
Trailer truck, front	36 in.
Trailer truck, rear	42 in.
Journals, diameter and length:	
Driving, main	12½ in. by 14 in.
Driving, others	11½ in. by 14 in.
Front truck	7 in. by 14 in.
Trailer truck, front	7 in. by 14 in.
Trailer truck, rear	9 in. by 14 in.



Cross section and elevation of the

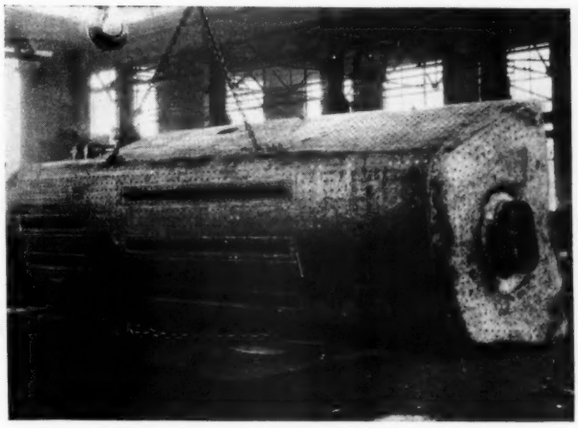
Boiler	
Type	Straight top
Steam pressure	250 lb. per sq. in.
Fuel, kind	"Rosebud" sub-bituminous
Diameter, first ring, inside	103¼ in.
Diameter, back ring, outside	110¼ in.
Firebox, length and width	266⅛ in. by 114¼ in.
Tubes, number and diameter	92—2¼ in.
Flues, number and diameter	280—3½ in.
Combustion chamber, length	72½ in.
Length over tube sheets	22 ft.
Grate area	182 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	610 sq. ft.
Syphons	262 sq. ft.
Tubes and flues	6,801 sq. ft.
Total evaporative	7,673 sq. ft.
Superheating	3,219 sq. ft.
Comb. evap. and superheat.	10,892 sq. ft.
Tender:	
Water capacity	21,200 gal.
Fuel capacity	27 ton
Wheels, diameter	37 in.
Journals, diameter and length	7 in. by 14 in.
General data estimated:	
Rated tractive force, 70 per cent	139,900 lb.
Booster tractive force, 50 per cent	13,400 lb.
Combined tractive force	153,300 lb.

Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	77.4
Weight on drivers ÷ tractive force	3.94
Total weight, engine ÷ comb. heat. surface	65.8
Boiler proportions:	
Tractive force ÷ comb. heat. surface	12.85
Tractive force × dia. drivers ÷ comb. heat. surface	742
Firebox heat. surface ÷ grate area	3.35
Firebox heat. surface, per cent of evap. heat. surface	7.95
Superheat. surface, per cent of evap. heat. surface	41.9

serve as a standby unit. In addition to these two pumps, the locomotive is equipped with two emergency Hancock injectors, having a pumping capacity of 104,000 lb. per hour. The boiler is designed to evaporate 120,000 lb. of water per hour.

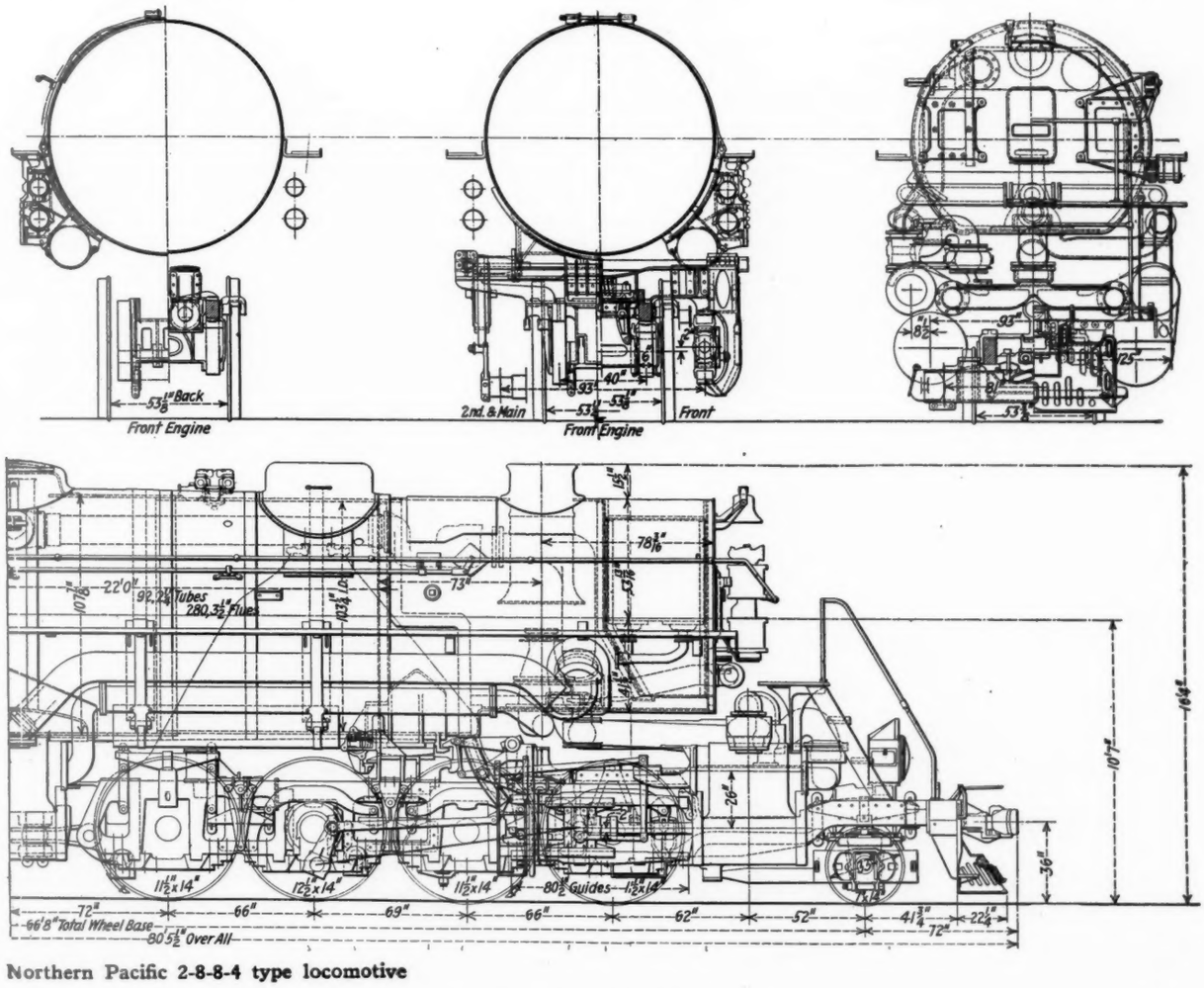
Steam Piping a Feature of the Design

The arrangement and design of steam piping is undoubtedly one of the features in the design of this loco-



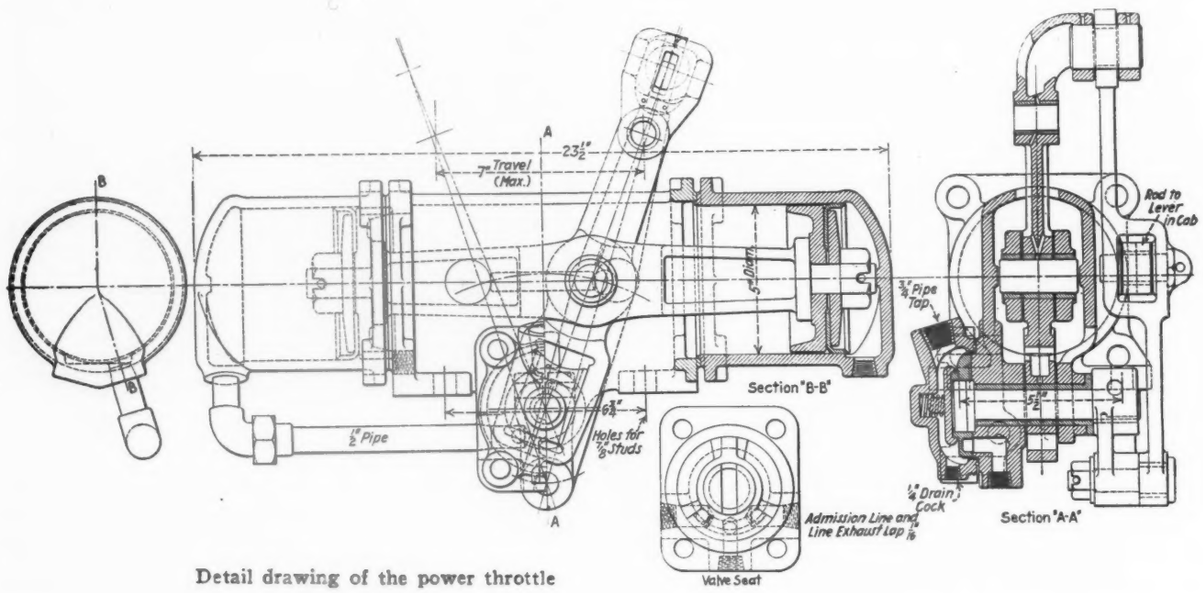
Crown of the firebox and combustion chamber

motive. Considering the amount of piping used, very little appears above the running board outside of the jacket covering the boiler. Feed-pump, water and steam connections are the only pipes laid over the jacket between the cab and the smoke box. The whistle, super-



Northern Pacific 2-8-8-4 type locomotive

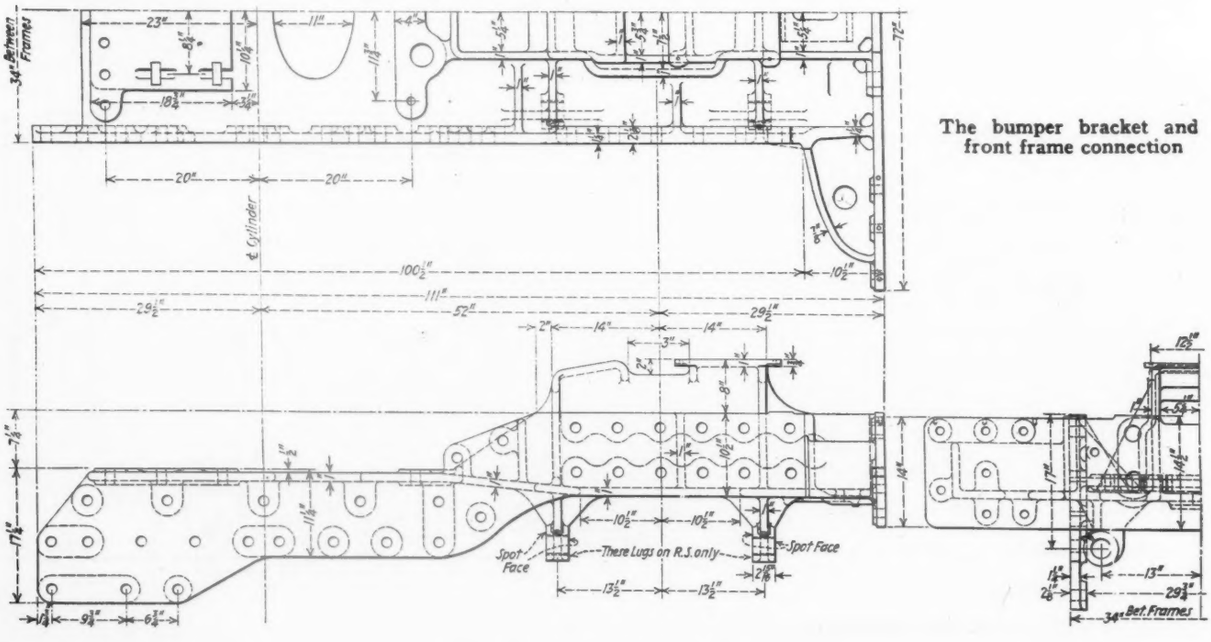
heater safety valve and pipe connections, and the exhaust pipe from the air compressor, are secured over the smoke box. The remaining piping is grouped together, as shown in the side view of the locomotive, to provide a maximum of accessibility together with good appearance.



Detail drawing of the power throttle

A number of novel features have been incorporated in the design of the pipes used for conducting the steam to the cylinders. The arrangement of the steam and exhaust pipes is shown in one of the drawings. The steam pipes to the cylinders of the rear engine are made of seamless steel tubing. They are not equipped with slip joints as has been the customary practice on locomotives of this type. Provision has been made for expansion by installing the pipe slightly buckled upward at the center. The independent pipes to each cylinder are so proportioned as to afford an equal supply of steam to each cylinder and thus eliminate wire drawing. This arrangement permits equal operating pressures in all four cylinders, which is of considerable assistance in reducing strain and wear on the side connections and journals.

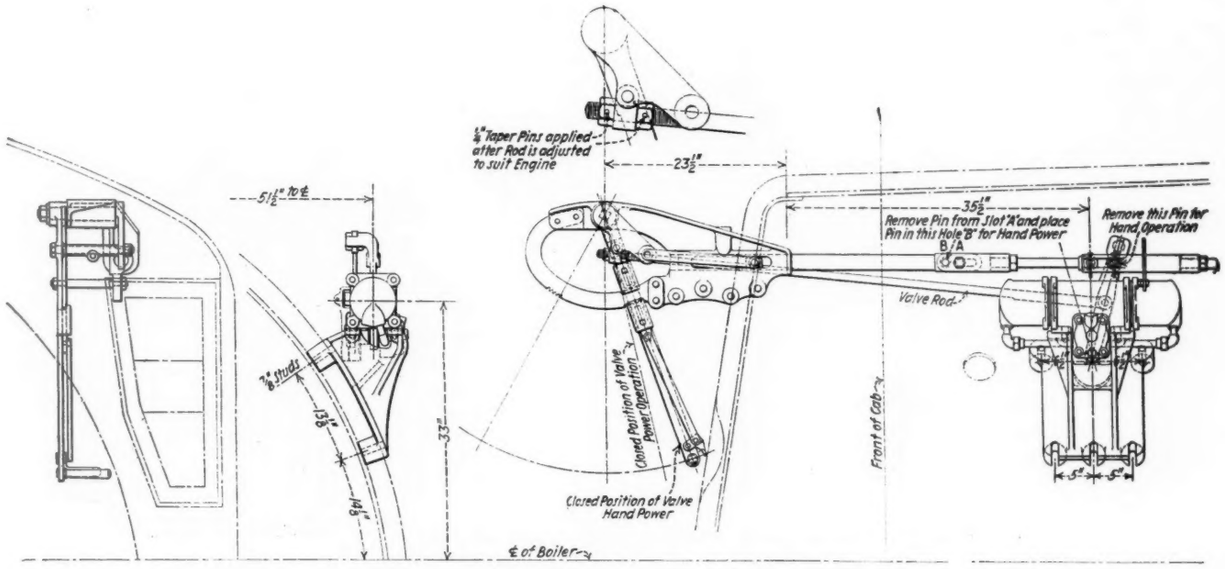
The steam supply pipes to the front cylinders are provided with cast-steel flexible joints of a design to secure balanced pressure on all parts of the joint, which relieves the packing of considerable pressure. These flexible joints are of the ball type, and are made steam tight with a special type of Johns-Manville steam-pipe packing. Steam enters the joint through the same size opening as the steam pipe itself and is diverted at right angles by means of a solid diaphragm, cast integral with



The bumper bracket and front frame connection

the joint itself. The top of this diaphragm is designed with a concave surface, which extends from the center to the outer edge of the outgoing ports. This type of concave construction distributes the pressure exerted by the steam over a large area. The space underneath this diaphragm is filled with magnesia cement. The steam

the locomotive. Brackets of cast steel are located directly opposite each other on both sides of the boiler, and are held in place by means of a forged steel strap which extends over the top of the boiler. The location of these brackets and supports is shown on the cross-section and elevation drawings of the locomotive. The brack-


1¼" Taper Pins applied after Rod is adjusted to suit Engine
23½"
Remove Pin from Slot 'A' and place Pin in this Hole 'B' for Hand Power
B/A
Remove this Pin for Hand Operation
Valve Rod
Closed Position of Valve Power Operation
Front of Cab
Closed Position of Valve Hand Power
℄ of Boiler

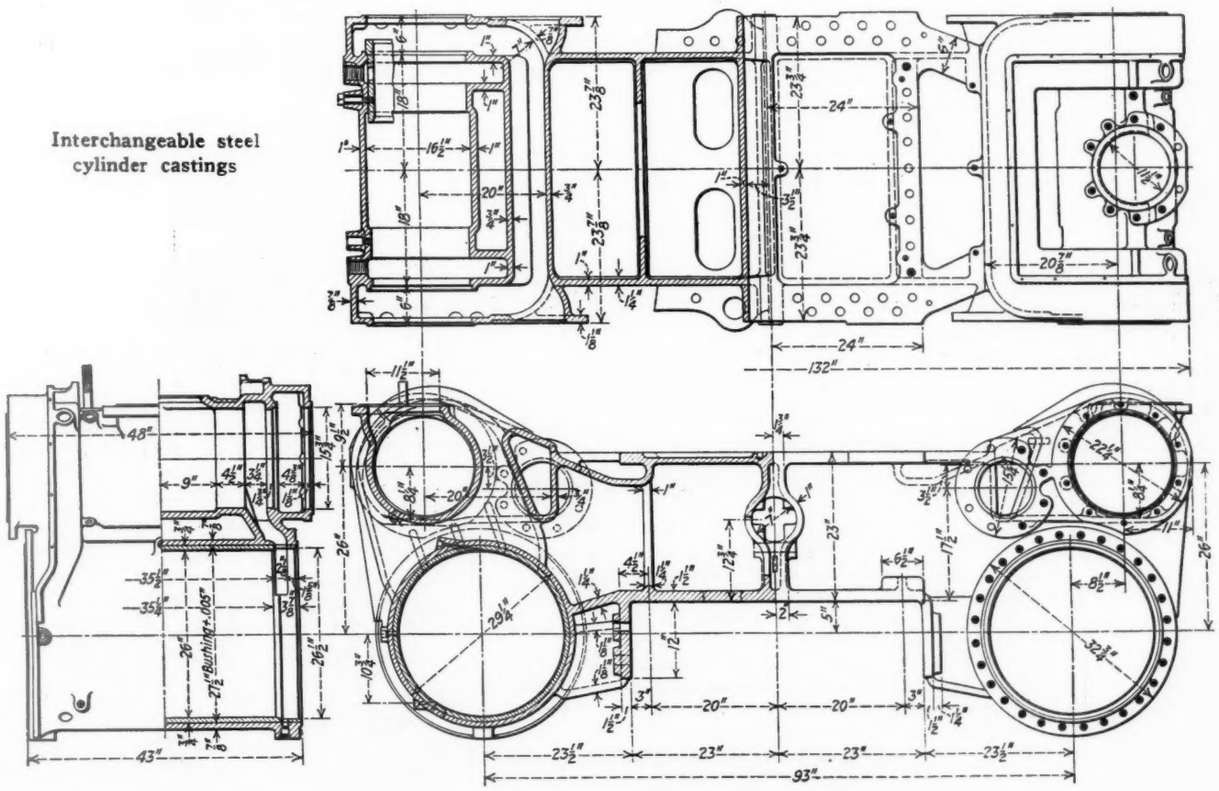
Application drawing of the power throttle gear

pipes extending above the table plate inside the smokebox are also encased in asbestos.

Another interesting feature is the method used by the designers for securing the piping and running boards to

ets are cast in two pieces, the piece next to the boiler being designed with recesses or cavities to suit the various diameters of pipe used, while the outside piece serves as a clamp to hold the pipes in position. The top

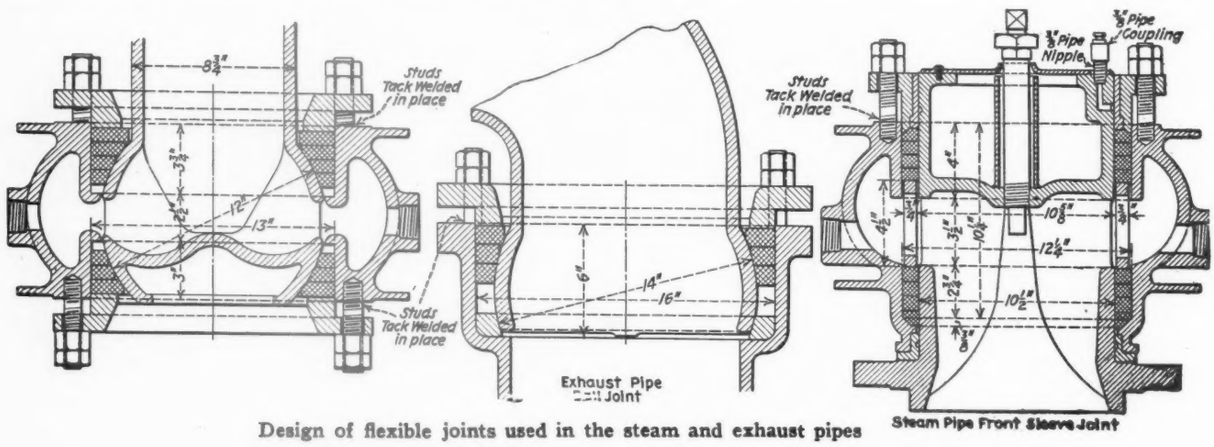
Interchangeable steel cylinder castings



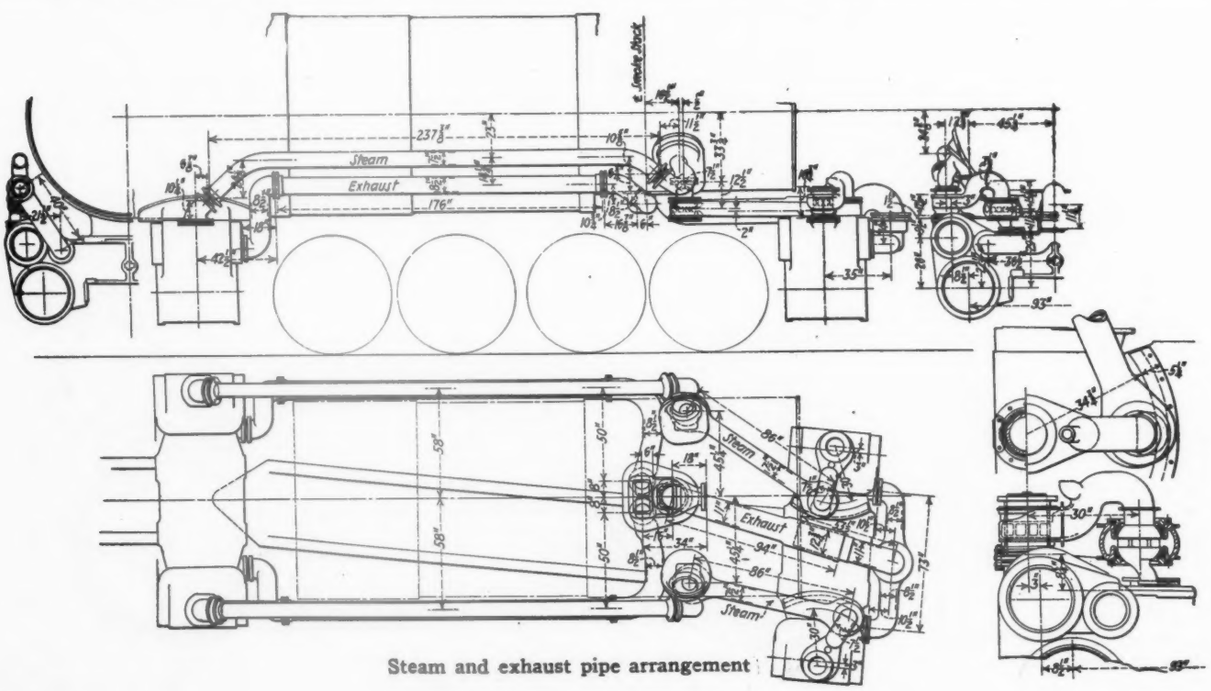
of the bracket is shaped to form a support for the running board. Irving subway flooring is used on the running boards and steps.

Power-Operated Multiple Throttle

Steam is admitted to the cylinders by means of an American multiple throttle which is power-operated. This is the first installation of a power throttle device on a steam locomotive. The device is air-operated, and was designed and built by the American Locomotive Company. Provision is made in the design for either emergency or continual hand operation. Referring to the application drawing of the power throttle gear, a slot, *A*, and a hole, *B*, are shown for the pin connecting the throttle lever rod. Although the slot *A* is shown as of considerable length, actually only about ¾ in. of play is allowed for the pin. The connecting pin is inserted through the slot *A* for power operation. The customary connections are used between the power device and the throttle valve. It will be noted that there is considerable difference between the closed positions of the throttle lever when power connected and when hand operation is used. This difference in the position of the throttle handle corresponds to the play of the connecting pin in slot *A* in the throttle lever rod. When the air-valve ports of the power throttle are closed, the connecting pin is in a central position in slot *A*, and the pin is at either end of the slot when the valve ports are open. When power-operated, the throttle handle is first moved a short distance, which takes up the slack of the connecting pin in the slot and causes the operating lever of the power throttle to open the air-valve ports slightly. It will be seen from the application drawing and also from the detail drawing of the power throttle, that the operating lever is a floating lever, connected to the throttle lever rod, the valve rod and the actuating mechanism of the air valves. The function of the slot *A* is to allow the main lever rod connection to move longitudinally an amount that will allow the floating lever connection to open the valve ports; then as soon as the valve ports are open, the vertical lever connection to the main throttle rod begins to move. This action takes place, of course, in both directions. If for any reason the air becomes discon-


Studs Tack Welded in place
Studs Tack Welded in place
Studs Tack Welded in place
Exhaust Pipe Ball Joint
Steam Pipe Front Sleeve Joint
Pipe Coupling
Pipe Nipple

Design of flexible joints used in the steam and exhaust pipes

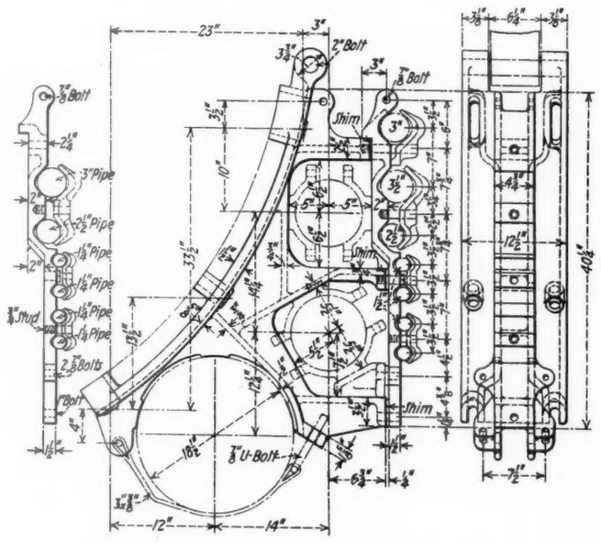


Steam and exhaust pipe arrangement

nected, then the main lever has to move an amount to take up the slot length before hand operation begins.

For emergency hand operation, in case the air fails, the throttle lever is pushed forward until the pin is in contact with the back of the slot *A*, and the steam throttle is then closed by hand. For continued hand operation, the pin is removed from the slot *A*, and placed in the hole *B*, and the valve rod is disconnected.

Steam distribution is controlled by a Walschaert gear, having a maximum travel of 7½ in. It is designed for 70 per cent cut-off and is controlled by an Alco power reverse gear, which is located above the crosshead guides of the rear cylinders. The reach rod, connecting the front and back reverse shafts, is placed on the center line of the locomotive, with its joint located directly above the articulated frame connection.



Running board and pipe bracket

With this arrangement, there is practically no distortion in the movement of the forward valves when the locomotive is traversing a curve.

All of the four cylinder castings are of steel and of the same design. Any one casting can be machined and drilled for use on the right or left side, front or back.

The crosshead guides are of an improved design, in which has been incorporated a single-bearing feature, together with provision for a sliding fit designed to prevent shearing of the guide bolts. The main block is of high carbon steel with a brass wearing surface, which is grooved for Alemite lubrication. This form of lubrication is also used for a number of other bearings, such as the valve motion and equalizer details.

The bumper bracket is a single steel casting which extends to the rear under the cylinder castings. It is bolted to the cylinder castings, and to the ends of the frames and forms a rigid frame construction from the face of the bumper bracket to the articulation joint.

The engine truck frame and radius bar are in a single steel casting. Outside bearings are used, and the journal boxes are bolted to the bearing portion of the casting. The wheels of the engine truck are 33 in. in diameter and have 7-in. by 14-in. journals.

The front drivers of each engine unit are equipped with the Alco lateral motion device. The main drivers have 12½-in. by 14-in. journals and the remaining drivers, 11½-in. by 14-in. All driving axles are hollow bored. Grisco boxes are applied to the bearings of the main and intermediate drivers of both engines. The hinged articulated joint is of the same design as that used on the standard U.S. R. A. articulated locomotives.

The Franklin booster operates at 50 per cent cut-off. It provides power to the rear wheels of the four-wheel trailing truck, the frame of which is of Commonwealth design. The rear trailer wheels are 42 in. in diameter, with 9-in. by 14-in journals and carry a load of 60,500 lb. This weight gives a factor of adhesion for the booster of 4.52. The booster exhaust pipe extends back through the tender to the rear of the coal board.

The Tender

The tender has a capacity for 21,200 gal. of water and 27 tons of coal, and is of welded construction throughout, The water-bottom tender frame and six-wheel equalizer trucks are of Commonwealth design. The wheels are 37-in. in diameter, with 7-in. by 14-in. journals. The coal bunker is equipped with a Standard coal pusher.

To Perform the Work of Two Mikado Locomotives

The new Northern Pacific 2-8-8-4 type locomotive is intended for experimental operation over the 216-mile district of the Northern Pacific from Mandan, N. D., to Glendive, Mont., across the so-called "Bad Lands" of western North Dakota and eastern Montana. This district has maximum grades of 1.1 per cent. The location and extent of the grades are such that helper districts are not practicable. Consequently large booster-equipped 2-8-2 locomotives with a tractive force of 63,000 lb. can haul but 2,225 tons between these points, which means that freight trains arriving at Glendive from the west with 4,000 tons, have to be split into practically two trains for movement from Glendive to Mandan. The same condition obtains westwardly at Mandan.

The relocation and revision of this 216-mile district has been the subject of many surveys during past years. These surveys developed that it would be extremely expensive to revise or relocate this line to provide a district having four- or five-tenths per cent ruling grades. With the abandonment of this idea, the mechanical engineers of the Northern Pacific and the American Locomotive Company set out to design a locomotive which would take through a 4,000-ton train in either direction over this district.

The contract with the American Locomotive Company contemplates the purchase of but one locomotive because of the fact that no experience data is yet available as to stoking capacity and other mechanical features in locomotives of these proportions. It is believed, however, that the locomotive will be successful in reducing by 50 per cent, the train-miles necessary to move freight traffic over this district. If it is unsuccessful, it can be assigned as a helper in mountain territory.

"The Mult-Au-Matic Method."—This is the title of an attractive 76-page catalogue recently published by The Bullard Company, Bridgeport, Conn. The Mult-Au-Matic, comprising in its respective models four or six independent machines automatically operated in combination on a series of identical pieces in process, is designed for the machining of all classes of work, including castings, forgings, or bar stock sections cut to length. Its operation in any combination, together with chucking and unloading of the work, is accomplished simultaneously at the selective rates individually required by each operation. Typical examples of practical jobs are illustrated in the catalogue.

Locomotive and Motor-Car Orders in 1928

Trend toward increased boiler capacity shown in the few orders placed during the year

ORDERS for locomotives in the United States during 1928 had the lowest total since 1921. Only 728 locomotives were ordered for domestic service last year. However, 98 locomotives were ordered in Canada, which made 1928 the best year since 1920, for the Canadian builders. As a whole, business for the locomotive builders last year was not good. Export orders followed the same general trend as did domestic orders. Only 27 locomotives were ordered from builders in this country for service in foreign countries. This was but one-half of the number ordered in 1927, and was the lowest number ordered for export since the beginning of the tabulation shown in Table I.

The New York Central was the largest purchaser of locomotives last year, procuring a total of 125, of which 100 was a single order for 4-8-2 types for freight service. The Canadian National, the Erie and the Texas & Pacific also purchased a considerable number of locomotives. The former ordered 60 locomotives of four different types for switching, passenger and freight service, while the last two roads mentioned, ordered 35 locomotives each. The Erie's order was for 2-8-4 types for freight service, and 30 locomotives ordered by the Texas & Pacific were for freight service and only five for passengers. It is interesting to note that of the 630 locomotives, as shown ordered for railroad service in Table II, 356, or 56.5 per cent, were for freight service and only 115, or 18.4 per cent, were for passenger service. Some of the orders were for locomotives for use in both freight and passenger service, such as the order for ten 4-8-8-2 types by the Southern Pacific.

A few years ago, one could readily differentiate between a passenger and freight locomotive by noting the number of wheels on the engine truck and the size of the drivers. But nowadays, the increased speeds at which many classes of freight trains are run; the development of passenger business to long hauls with cars providing the best to be had in travel comfort and luxury, with the attendant increase in weight per car, as well as in the number of cars per train, has developed a demand for locomotives of large capacity, capable of operating at high speeds over extended periods of time. Locomotives designed for heavy passenger service are also suited for manifest freight business. The Southern Pacific's order for single-expansion 4-8-8-2 type locomotives, for use in both freight and passenger service is, perhaps, an extreme example of this development*.

Most of the orders in 1928 were placed during the last few months of the year. Although 1928 was a comparatively poor year, the order for 100 heavy freight locomotives placed in December by the New York Central for delivery during the early part of 1929, is the largest single order for locomotives that has been placed since early in 1926. These locomotives are of the 4-8-2 type.

Table II shows the types of locomotives ordered in 1928 for railroad and industrial service and for export. Of the 630 ordered for railroad service, 151, or nearly 24 per cent, were 4-8-2 types, 73, or 11.6

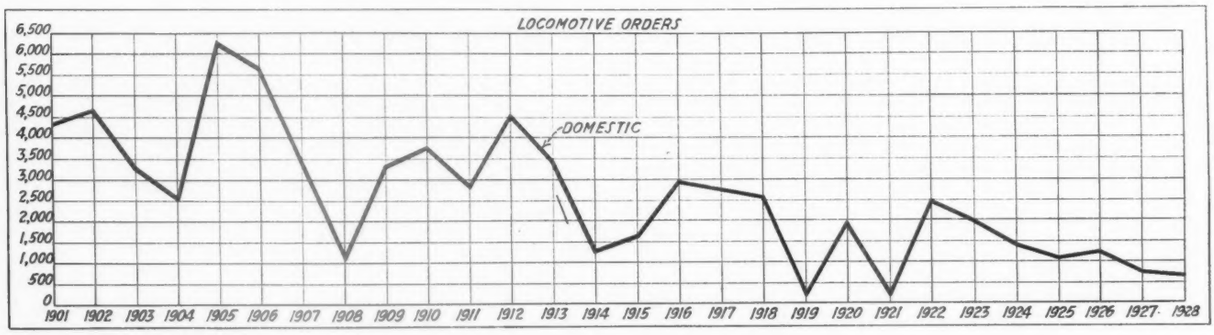


Chart showing the locomotive orders, 1901 to 1928

Table I—Orders for Locomotives Since 1918

Year	Domestic	Canadian	Export	Total
1918	2,593	209	2,086	4,888
1919	214	58	898	1,170
1920	1,998	189	718	2,905
1921	239	35	546	820
1922	2,600	68	131	2,799
1923	1,944	82	116	2,142
1924	1,413	71	142	1,626
1925	1,055	10	209	1,274
1926	1,301	61	180	1,542
1927	734	58	54	846
1928	603	98	27	728

* These locomotives were described in the January, 1929, *Railway Mechanical Engineer*, page 4.

per cent, were eight-wheel switchers, and 55 or 8.7 per cent were of the 2-8-2 type. It will be noted that locomotives having two-wheel engine trucks and four-wheel trailing trucks, and locomotives having both four-wheel engine and trailing trucks, are receiving favorable consideration from the railroads. Orders for locomotives having these engine and trailing truck wheel arrangements are shown in Tables III and IV.

Regardless of the fact that the total number of locomotives ordered by the railroads in 1928 and 1927, show a considerable decrease from 1926, when 1,362

Table II—Types of Locomotives Ordered in 1928

Type	Railroad	Industrial	Export	Total
0-4-0	0	5	0	5
0-6-0	22	9	0	31
0-8-0	73	0	0	73
2-6-0	3	1	0	4
2-6-2	0	2	0	2
2-8-0	6	1	3	10
2-8-2	55	2	6	63
2-8-4	42	0	0	42
2-10-0	4	0	0	4
2-10-2	15	0	0	15
2-10-4	46	0	0	46
Articulated	28	3	6	37
4-4-0	1	0	0	1
4-6-0	11	0	2	13
4-6-2	7	0	4	11
4-6-4	35	0	0	35
4-8-2	151	0	0	151
4-8-4	63	0	0	63
4-12-2	23	0	0	23
Geared	1	24	0	25
Oil-electric or gasoline	4	9	2	15
Electric	35	15	4	54
Miscellaneous	5	0	0	5
	630	71	27	728

locomotives were ordered for railroad service, orders for locomotives of the types given in Tables III and IV, have increased or remained substantially the same. The year 1925 saw the introduction of the 2-8-4 and the 2-10-4 types and the following year, the 4-6-4 and 4-8-4. A total of 107 locomotives, having four-wheel trailer trucks, was ordered in 1926, 249 in 1927 and 186 in 1928. Of the total number of locomotives ordered for railroad service, 8.2 per cent in 1926, 31.5 per cent in 1927 and 26.5 per cent in 1928 had four-wheel trailing trucks. This substitution of the four-wheel trailing trucks for the two-wheel in well-established wheel arrangements, is indicative of the effort to develop the utmost in power output with a minimum increase in size and total weights.

The Articulated Type Locomotive

Last year also marked another year in which the record had been broken with respect to the largest locomotive built in the world. Although this record has

Table III—Orders for Locomotives Having Two-Wheel Engine Trucks and Four-Wheel Trailing Trucks

Road	Type	No.	Weight, lb.	Tractive force. lb.
Central Vermont	2-10-4	10	415,000	.....
Chicago, Burlington & Quincy	2-10-4	6	.....	.....
Erie	2-8-4	35	461,470	71,000
International Great Northern	2-8-4	5	404,000	69,400
Texas & Pacific	2-10-4	30	452,000	84,600
Toronto, Hamilton & Buffalo	2-8-4	2	383,000	69,000

been broken at frequent intervals since the days of the Stourbridge Lion, the Best Friend of Charleston and the York, the largest locomotive in the world, always attracts considerable attention, not only on the part of railroad men, but the general public as well. The single-expansion articulated 2-8-8-4 type locomotive, delivered to the Northern Pacific in December, 1928, breaks a number of world records, especially with respect to overall length and weight, which exceeds a million pounds. A description of this locomotive appears elsewhere in this issue, and on the whole, it represents a bold step forward in the attempt to increase locomotive capacity.

Both this locomotive and the Southern Pacific's 4-8-8-2 types, are good examples of where the articulated type locomotives are looked upon with favor by a number of railroads as the solution of traffic problems, especially over divisions having heavy grades that serve somewhat as a "neck in the bottle" in moving trains over the entire system.

As shown in Table II, 28 articulated type locomotives were ordered in 1928. The total of orders for this type has been approximately the same in previous years. Thirty-two were ordered in 1927, 17 in 1926, 22, in 1925, 34 in 1924 and 53 in 1923. The Great Northern built 16 locomotives, having a 2-8-8-2 wheel arrangement in its own shops. This order and the order for 10 by the Southern Pacific were the largest orders for articulated locomotives placed during 1928.

Comments on Design

The principal tendency in design during the past year has been the effort to take advantage of every facility which has been developed to increase the amount of boiler capacity possible to obtain with a given weight on the drivers. This tendency, in connection with the increased use of the four-wheel trailing truck, was discussed in a preceding paragraph. Another example of this tendency has been the use of nickel steel in the barrel sheets of locomotive boilers by the Canadian Pacific. In the two 4-8-4 type locomotives built by the Canadian Pacific at its Angus shops, the use of nickel steel has been extended to the firebox sheets, the tube sheets, staybolts and the arch tubes and carbon steel has completely replaced iron

Table IV—Orders for Locomotives Having Four-Wheel Engine Trucks and Four-Wheel Trailing Trucks

Road	Type	No.	Weight, lb.	Tractive force, lb.
Atchison, Topeka & Santa Fe	4-8-4	4	.....	.....
Boston & Albany	4-6-4	5	353,000	44,800
Canadian National	4-8-4	20	389,000	.....
Canadian Pacific	4-8-4	2	424,000	60,000
Chicago, Rock Island & Pacific	4-8-4	1	420,000	.....
Delaware, Lackawanna & Western	4-8-4	20	416,000	70,000
Denver & Rio Grande Western	4-8-4	10	408,500	61,000
Great Northern	4-8-4	6	.....	.....
Michigan Central	4-6-4	5	348,000	42,300
New York Central	4-6-4	25	352,000	42,300

in such details as tubes, braces and rivets. This permitted an increase in boiler pressure to 275 lb., with no greater weight than would have been required under the practice of two years ago in a boiler for 250 lb. pressure.

Most of the improvements in design during 1928, were along the line of refinements to locomotive parts and appliances. The problems created by the necessity of conveying high-pressure steam through flexible pipes to the front cylinders of articulated type locomotives have resulted in several different steam pipe designs. The use of the booster, or auxiliary locomotive, is increasing, due to the fact, in all probability, of the increased ability of the boilers to care for the steam demand. The past year has also seen a more extended use of steel castings, especially the extention of the use of locomotive bed castings. This bed casting combines in a single unit the frames and cross ties, and is being used in an increasing number of new locomotives. In several instances, the bed castings have included the cylinder.

The President Cleveland of the Baltimore & Ohio, which was on exhibition during the conventions of the Mechanical, and Purchases and Stores Divisions at

Atlantic City, N. J., in June, 1928, was practically the only outstanding locomotive in the design of which the water-tube firebox was incorporated. The equipping of this locomotive with the Caprotti valve gear, the first to be so equipped in this country, makes this locomotive one of the outstanding in the point of interest of those built during the year.

The development of the long locomotive run has been a factor in the building of tenders of large capacity. Tenders exceeding 20,000 gal. and 21,000 gal. water capacity, are now becoming quite common, especially for freight power. This development has also created a number of lubrication problems which are being attacked in a variety of ways by a number of railroads. This applies particularly to the lubrication of engine truck boxes and, to a lesser extent, to crank pins. The use of special types of driving boxes on the main journals is also being extended in the replacement of the long-established crown bearing type.

Table V—Orders for Rail Motor Cars and Trailers

	1922	1923	1924	1925	1926	1927	1928
For service in the U. S.	51	77	120	149	142	180	175
For service in Canada	7	3	12	7	4	9	10
For export	1	22	...	34	32	12	9
Total	59	102	132	190	178	201	194
Motor cars	50	93	112	171	161	176	172
Trailers	9	9	20	19	17	25	22

There are still many engineering problems to be solved in connection with the development of the steam locomotive. Considerable interest has been shown in the problems pertaining to counterbalancing, which perhaps indicates that this will be one of the next details to come in for improvement. The drafting of locomotives is a problem which has never been solved satisfactorily; although much work has been done at various times in an effort to develop rules or proportions which could be generally applied. So far, the usefulness of rules so developed, has been confined to relatively small limits of variation in the proportions of the locomotive. This problem is again receiving a large amount of attention.

There is a real need for research or investigation on such subjects as tractive force formulas for three-cylinder and two-cylinder locomotives with maximum cut-off, of the development of ratios and proportions of locomotives equipped with modern appliances; such as superheaters, feedwater heaters, etc.

Table VI—Power Plant Capacity of Rail Motor Cars, U. S. and Canada

Horsepower	1925	1926	1927	1928
100 or less	13	14	2	5
Over 100 to and including 125	5	7	..	1
Over 125 to and including 150	9	..	..	3
Over 150 to and including 175	20	1	..	1
Over 175 to and including 200	49	3	3	1
Over 200 to and including 250	36	65	43	13
Over 250 to and including 300	2	26	76	64
Over 300 to and including 350	..	..	..	24
Over 350 to and including 400	2	..	..	17
Over 400	..	19	16	25
Unclassified	..	..	24	7

Locomotive springs, the use of alloy steels and other metals in locomotive construction, are also subjects which are becoming of increasing importance.

Diesel and Oil Electric Locomotives

Table II shows that of the 15 oil-electric locomotives ordered during 1928, only 4 were for railroad service. One of the four was ordered by the Erie, two by the Hoboken Manufacturers' Railroad and one by the Illinois Central. All four have the same wheel arrangement, 0-4-4-0 and are powered with Ingersoll-Rand oil engines, and have General Electric transmission. The locomotive for the Erie and one of the two ordered by the Hoboken Manufacturers', develop a tractive force of 36,000 lb. and the remaining two, develop a tractive force of 60,000 lb. each. The number of locomotives ordered for domestic service, classified under the general head "Oil-electric or gasoline" in Table II, is the same as the number ordered for the same service in 1927. Of the locomotives ordered in 1927 for domestic service, nine were for railroad service and four for industrial use. Fifteen oil-electric, or gasoline locomotives, were ordered for domestic service during 1926.

There are now more than 40 Diesel or oil-electric and gasoline locomotives now in service in the United States and Canada. This type of motive power has demonstrated its practicability for switching service, which, no doubt, was the reason for the large number of orders placed by industrial concerns last year.

The past year, however, saw several locomotives of this type designed for regular road service. Two Diesel-electric locomotives are now in road service on the Putnam division of the New York Central, one in passenger and the other in freight service. The 2,660-hp. Beardmore Diesel-electric locomotive, which was recently completed for the Canadian National, is undoubtedly the outstanding development in this field. This locomotive develops a starting tractive force of 100,000 lb. and is the first locomotive of this type to be placed in service in America which at all approaches in horsepower capacity, the requirements for other than light branch line operation or switching service.

Table VII—Comparison of Rail Motor Car Weights, U. S. and Canada

Weights	1925	1926	1927	1928
25,000 lb. and under	6	7	..	..
Over 25,000 lb. to and including 50,000 lb.	19	7	..	..
Over 50,000 lb. to and including 75,000 lb.	74	2	4	..
Over 75,000 lb. to and including 100,000 lb.	27	79	29	5
Over 100,000 lb. to and including 125,000 lb.	7	32	88	69
Over 125,000 lb. to and including 150,000 lb.	..	5	21	53
Over 150,000 lb.	..	1	..	9
Unclassified	..	..	26	22

Rail-Motor Car Orders in 1928

Table V shows the orders for rail-motor cars and trailers for each year beginning with 1922. During 1928, orders were placed in the United States and Canada for 172 motor cars and 22 trailers, making a grand total of 194. Of the total, 175 were for service in the United States, 10 for service in Canada, and 9 for export. Prior to 1922, relatively few modern self-propelled passenger cars were placed in service on the steam railroads of North America. However, since that time, this type of equipment has rapidly grown in favor, as shown by the increase in the total figures for each year in Table V, and at the present time, there are approximately 900 rail-motor cars and trailers in service in the United States alone. About 440 of the rail-motor cars have electric transmissions and the remainder have mechanical transmissions.

It will be noted from Table VI, that the trend in the design of rail-motor cars is toward larger power plant capacity. In 1925, there were only two rail-motor cars ordered with power plants developing over 350 hp. and none were ordered that developed over 400 hp. However, in 1926 there were 19 rail-motor cars ordered having a power plant capacity of over 400 hp. and 16 rail-motor cars came under this classification in 1927. During the last year, 25 rail-motor cars having over this power plant capacity, were ordered.

The trend toward the larger power plants is indicated in a striking manner in Table VI, by observing the largest number of rail-motor cars ordered each year, with respect to power plant capacity. Likewise, the trend towards greater weights is indicated in a similar manner in Table VII.

The year 1928 saw the advent of the Diesel engine in the rail motor-car field. Orders were placed by the Canadian National during the year for several cars equipped with Beardmore Diesel engines. Several rail-motor cars were ordered for service in the United States, the engines of which were designed to use distillate as fuel. One rail motor-car was ordered by the Chicago, Milwaukee, St. Paul & Pacific to be powered with a steam engine furnished by the Railway Locomotor Company, a development that will be watched with considerable interest.

A number of western railroads have converted some of their rail motor-cars of an early design, such as the McKeen type, and equipped them with gas engines of modern design and electric transmission. The Chicago, Rock Island & Pacific converted three postal cars to self-propelled operation, equipping them with dual-power plants of 800-hp. capacity. These cars are not only available for motor passenger service, but may also be used as locomotives for branch line freight service. The power plants installed by the Rock Island in these cars are of interest in that they mark the introduction of the eight-cylinder motor in the rail-car power field.

Highball Scott Dissertates on Advertising*

Bill Babbitt learns from a master mechanic what should not be included in a good technical advertisement

HAD Bill Babbitt been satisfied with the letterheads he used for his business correspondence, he would not have gone over to Rockside to see a printer in regard to getting out some new business stationery. Had he not been in Rockside he would have missed seeing his old friend Highball Scott. However, while in town, why not see Highball first. Bill had some photographs from which might be selected an excellent subject for either advertising cuts or a letterhead illustration to use on the Evergreen Nursery Farms stationery. Thus it came about that Bill dropped into Highball's office one morning to find that worthy railroader busily digging through a stack of mechanical magazines which were always on file in Highball's office.

Bill and Highball get together again

"Morning, Highball."

"Hello, Bill. Sit down and be at your ease. Just hunting something."

"Hope you haven't mislaid any bank notes or Liberty Bonds in the pages of your magazines, Highball."

"No, it wasn't that. Sit down, sit down, I will explain it all to you sometime. How have you been?"

"Fine, Highball," answered Bill. "Things going good. Came over to get some letterheads and envelopes fixed up. While I am here I am going to ask your opinion of my scheme for a letterhead for Evergreen Nursery Farms stationery."

"Glad to help you if I can. What's your idea?"

"Just to show what a little shrubbery will do, Highball, in the way of beautifying a property, look at this little place I first bought with the intention of tearing down the house and utilizing the grounds. After consideration I decided the property was worth repairing, at the same time making it more presentable. To make a long story short, the first picture shows the place as it looked when I bought it. The second one shows it after a few repairs had been made and the ground set off with some shrubbery arranged to the best advantage. What do you think of it?"

"Nice looking little property, Bill, although the improved appearance is not entirely due to the shrubbery. The new roof, a chimney evidently rebuilt, the house painted, porch repaired, and that lawn you have in front go a long ways towards making the shrubbery show to its best with an attractive background. Funny thing you chanced to drop in just at this time. I was busy running through these magazines in search of an ad. I saw it some months back. Don't remember the name of the company."

"What kind of an ad. was it, Highball," asked Bill?

"Oh, just a little shop tool. It might as well have been a squirt can for safety-valve oil, or a left-handed monkey wrench as anything else, because, of course, that is what it wasn't. Now naturally in running over the advertising pages in search of this particular device, I have been looking at a number of other adver-

* The sixth of a series of Articles written by a former peddler.

tisements. As I leaf the pages over, you know the thought struck me that there is a whale of a difference in the way people who have goods to sell go about the job of announcing the fact to prospective customers through the medium of trade journals."

"I don't quite get the idea, Highball. I realize there is a lot of difference in advertisements. Of course there would be. In the first place no one cares to copy the other fellow's stuff, and then too, wouldn't you consider that it is advisable for an advertiser to put his sales talk before you in such a way as to attract your attention?"

"Yes, of course that is right and proper, but haven't

Highball objects to poor firing and I. C. C. defects

you ever noticed that in going about the business of presenting the subject to the readers, some of the people who put out advertising, have a better method of getting to the readers than others have? Did it ever occur to you that some advertisers seem to give a whole lot more thought of what the reader's opinion will be than others do?"

"Can't say that I have ever noticed that particularly, Highball. I do know that some advertisements seem to impress you more favorably than others, much the same as some salesmen impress you more favorably than others. That reminds me of a line I once read in a trade journal. As I recall it now it did emphasize the identical thought that you have just mentioned. What was it now? Oh, yes, something like this: 'The purpose of our advertising matter is to sell the men your salesmen never see.' In other words, the publisher of that particular magazine preaches the sermon in a single sentence. Fact too. There is one thing certain, i.e., that all literature sent out by a company reaches its destination. A man may be in conference; he may be dictating; he may be a little late in the morning or he may be too busy to see you today, but Uncle Sam's mail, without any ceremony, goes right into his office and must be disposed of. Sitting here I can see that certain forms of advertising wind up in your waste basket. At the same time I can see that certain other forms of advertising are carefully preserved in your magazine files, and that you pay quite serious attention to the advertising in your mechanical magazines is shown by two facts. The first, that you keep the magazines on file. The second, as you have just now told me, you were searching through back numbers of your magazines for an advertisement that you had seen sometime. You never met a representative of this company which you mention. Probably you never had a letter from them, and yet you noticed at one time that they had a product which was of interest to you. In this case the statement I quoted a few minutes ago is literally true. That one advertisement has sold a customer who has never been approached by a representative of the sales company."

Advertising Pages Should Create Interest

"Sound talk, Bill, which reminds me of something I read sometime ago. This man, I understand, was not an advertiser, but he was a salesman. He expressed himself as not being able to understand why advertising should not convey to the readers practically the same things as a highly successful salesman would use in a personal sales talk. If such is the case let me say to you that I have met men whom I considered were highly successful salesmen who did not talk at all like some advertisements read. Now bear in mind that I am not an advertising man. I never wrote an advertisement in my life. I may or may not be able to judge good from bad in advertising. By the same token, however, I am not a hen, but I can tell a bad egg from a good one. In other words, Bill, I am the consumer in either case, so while my opinion as a layman may be of no value, between old friends there is no harm in commenting on 'advertising as she is spoke.'

"Here is a case in point. This firm has a machine to sell. We probably will buy a machine of this type some day. The magazine in which the ad appears is a railroad magazine. Here is a cut of the machine. Good looking machine. Probably all right. Let us look over the reading matter. Do we see sizes, capacity, floor space, type of bearing, lubrication, output or any other little details mentioned? No, but down below we are told to 'Call at Booth steen.', such a date at such and such a show. Now if this show happens to be run in connection with the annual meeting of the National Baby Carriage Manufacturer's Association, the chances of a railroad man attending that show are rather remote, and as they are rather remote, why occupy a whole section of valuable advertising space telling me nothing?"

"Didn't that ad create interest on your part, Highball?"

"Yes, certainly it did."

"Well, if it created interest on your part, isn't it carrying out it's purpose?"

"Might be much in the same manner as you would create interest if you dropped in on a stranger some day and told him you had some beautiful shrubbery which you wished to sell him and, while you would spend several dollars in car fare and your time to call on your prospect, you would conclude by saying that you didn't know just how large these shrubs would grow, whether they shed their leaves every fall or not, but if the prospective customer would drive over to Stringville some day, he could see some of them growing there. Maybe that would be successful salesmanship?

"Here is another advertisement. This fellow calls attention to the strength of a powerful locomotive. As a prospective customer I don't care a whoop how powerful that locomotive is. I fail to see what the power of a locomotive has to do with the output of a grindstone or a corn sheller."

"You don't get the idea, Highball. Here is that artist's thought. He pictures a locomotive to call to your mind strength, speed, and endurance, and tries

to establish a parallel train of thought in your mind concerning the durability and the use of his particular product. That locomotive is only used figuratively, you understand."

"Oh, I see. Something on the same order as if a tooth paste company, for example, would precede their advertisement with a cut of a sausage grinder to show the endurance in a set of teeth cleansed and conditioned with their product?"

"Well, the sausage grinder might be a little far fetched, but I see that you are looking towards daylight. The locomotive merely symbolizes the thought of the writer of this ad."

"I see, I see. Here is one in a recent number of a reputable publication. This advertisement shows that, since the installation of a particular machine tool, the operator is now doing a certain job in one hour's time that formerly required a day. You look at the size of the job, Bill. You know the material, and you know mighty well with the average machine you should do those pieces in not more than two hours each. The reason I know this is that since reading that ad, I checked up on the job in our shop and I know that on a machine that has been in service for more than twenty years, our man is doing the same pieces in less than two hours and is not hurting himself at that. If what is told in the advertisement is the positive truth, I would like to know the whereabouts of the shop that allows a man to putter away eight hours on a job that can be done on a machine that you might consider to be out of date in less than two hours."

"Well, you see, Highball, the thought is there; it is a contrast. There is no question that if you can do the job in two hours on a machine that is due for retirement it should be done in an hour on a good, stiff-backed, up-to-date machine."

"I agree with that all right, but why mislead me with a fairy story? You might just as well, in my judgement, save your time if you were trying to make that ad talk to me as a highly successful salesman talks, as to try to plant the impression in my mind that I would make an eight to one production gain by the use of this machine. Isn't it possible, Bill, that the readers will decide there was something fishy about the whole advertisement?"

"He might at that, Highball. It might have been better for him to say that a great many shops were doing this job at the rate of two hours each, but with his particular machine, the output could be doubled."

"Well, I would take the whole thing more seriously if he did that, Bill. But that does not explain this other fellow. He gives you a good start in his ad; just a hint, however, of what his machine embodies, and then concludes after he has my curiosity duly aroused, by saying 'write your jobber for information, or write us.' I believe he would create a better impression in the mind of the reader if he would say 'we will send a pamphlet if you write us.' Not that it makes any difference in particular, but when he switches me around to write the jobber, it has a certain flavor of the bad railroad habit of 'passing the buck'."

"How about this ad, Highball? Here is a fellow that does not show a modern locomotive. He shows an old timer. Anything particularly impressive about that ad?"

Highball Likes Historical Ads

"I read every ad that embodies something of a historical nature like as covered by that fellow's talk. Here is the point. I see illustrations of modern locomotives every day and they are regular locomotives, too. They are not some mythical piece of machinery that exists in the artist's imagination. I also see where the writer of that advertisement symbolizes something in using that picture of a locomotive of Civil War days. He has got the talk across to me that his concern was building equipment for locomotive repairs at the time that particular type of locomotive was in use, and that his company is still building railroad shop equipment. Obviously, that manufacturer has a good product or he would not have been able to stay in business from the time of the Civil War up to the present day. I believe in that case that the locomotive picture performs a two-fold purpose. First, it attracts my attention because such locomotives had passed into history before my advent into the railroad field. Now, as a shop man, I am interested in comparing that locomotive with those of the present day. The development of the locomotive in a matter of over half a century is a decidedly interesting subject.

Mail reaches its destination

"Whether that illustration is true to life or not, I don't know. It doesn't make any difference. In a general way it looks good to me, and there is sufficient detail to convince me that the men who built the locomotives of that day were real mechanics. They laid a good foundation for us to build on and I am glad to look at something that recalls their efforts. The second purpose is that which I have already mentioned, that the development of the product of this particular concern has paralleled the development of the locomotive. In other words, as we would say in our village daily they are 'old and highly respected citizens of our community'."

"I judge from your remarks that an advertisement carrying an illustration, although rather faintly connected with the product being advertised, interests you so long as it tells you something you do not know," said Bill. "Is that your thought, Highball?"

"That's the idea."

"Well if such is the case, doesn't this picture of a speeding passenger train running along a well ballasted track with a background of mountain forest arrest your attention? For example, let us look at this ad. Now what is wrong with that, Highball?"

Illustrations Should Show True Conditions

"Umm, lessee. First why is the ad. on that page? Because this particular manufacturer whose name appears at the bottom, has a tool to sell. Very good. Up in one corner is a photograph of the machine. Alongside, and as a background, is a rather indistinct

picture of a shop interior. The man in the foreground of the picture points towards a locomotive. I don't see a whole lot about that man or that locomotive in the picture that concerns the machine. Another place on the page is your locomotive with a passenger train and proper scenic setting. You say the locomotive is speeding, Bill. How do you know it is speeding?"

"Don't you see that cloud of black smoke trailing back along the train?"

"Yes, I see it."

"Well that symbolizes motion. Now, if the locomotive were standing still, that smoke would go straight up."

"Yes, but what a rotten job of firing! If the Carbon Valley engines smoked up things in that manner at some of the towns along the line, the smoke committee and the city dads would raise a howl to the heavens. And it would reach our ears—plenty too. Now that steam blowing out around those cylinders and trailing back: that symbolizes motion—action—speed, too?"

"Certainly don't you grasp it?"

"Did you ever see an engine on the Carbon Valley with such a cloud of steam around her front end that the 'hogger' couldn't see anything south of the running boards? If what is shown in this picture was typical of conditions on this railroad, I have an idea there might be some strange faces in the motive-power department before a great while."

"What you say is true, Highball, but doesn't this old Civil War locomotive show quite some smoke coming out of the stack?"

"I'll admit that. At the same time let me whisper to you that fuel economy, which embodies some study of combustion in a locomotive firebox, has advanced noticeably in the last half century. Going a little farther with this ad, after I have told you I am not interested in this phantom view of a shop interior, nor in the speeding locomotive of a passenger train, let us get back to what the ad really tells us about this particular machine. Here she is—a little reading matter. About a half page wide and three inches long. Four paragraphs: One tells about transportation; the next tells you to note the rugged strength of the various members of the locomotive; another tells us a little more about the locomotive, and the fourth informs us that certain parts of this locomotive are shaped by the use of this particular machine. Never a word about the size and capacity of the machine—whether it is built in one or in six sizes or any other information of that nature."

"How would you utilize that space, Highball?"

"Going back to the example of your narrow-gage hen producing eggs, I admit I might be as incapable of teaching a hen how to lay an egg as teaching an advertising man how to write his advertisements. But we will all agree that we prefer fresh eggs. We know how we want them cooked, too. Same with the ad. If this particular advertisement showed me how best to locate this machine tool in relation to its surroundings, or if there was a hint concerning the foundation or possibly a little advice as to how to get the best operating results from the machine, that kind of a picture of the inside of a shop would be worth while."

"I don't know but what you are right, Highball."

"From the viewpoint of the fellow eating the egg, I know darned well I am right. Taking a hens-eye view of the subject, I may be wrong. If I am, so is this fellow who has the clothing sale advertisement in the daily paper. Notice that illustration at the head of the block advertising the overcoats. You see that advertiser shows the overcoat being worn by a fine, upstanding looking fellow. Notice too that the lad's trousers and hat, as well as his collar and tie, are the latest thing in men's styles. I also note that the young man's shoes are in keeping with the rest of his outfit. Now, you might dress his feet in miners' boots or hobnailed shoes, to symbolize the lasting qualities of the overcoat."

"But, Highball, you never saw a properly attired man wearing a dress overcoat, kid gloves, and hobnailed shoes, did you?"

"No, can't say that I ever did, Bill. Neither did I ever see a lot of properly maintained locomotives with leaky cylinder-head joints, valve-stem and piston-rod packing, blowing, and one or two cylinder cocks stuck open, while the engine is doing her stuff between terminals. Bill, here are illustrations of five locomotives, each and every one of them either smoking sinfully or leaking steam at a rate that would chill a locomotive man's blood."

"Oh, yes, get the humor of this one, here. 'Put your problems up to our experts. They will advise you.' If the experts don't know any more about locomotives than the advertising syndicate does, I might hesitate about seeking their advice. However, I don't believe that is the case. Some of these concerns I personally know have men who can tell you anything that you need to know concerning the application of their product. Not only that—many of them can give you advice on almost any shop subject you see fit to submit to them, and their advice is valuable too. They know their stuff. It might be a good idea for the advertising man to shoot his copy over to the mechanical experts once in a while in something of a 'What's wrong with this picture' spirit."

"Here is a well known machine-tool builder's ad, Highball. What would you say about this?"

"I see a machine tool, a list of the sizes or capacities in which the tool is built. A job in the chuck—apparently set up ready to do business. Over here at the right is a layout of the tooling for this particular job."

"You like that, do you Highball?"

"Who wouldn't? Not only does that tool builder show us that they machine that particular piece, but they show us how to do it. I consider that information worth while. Information pertaining to the machine is vastly more interesting to me than a photograph of the automobile in which this particular piece is used. In other words this advertiser tells us something that we should know."

One Way of Attracting Attention

"How about this advertisement, Bill? The gent on the scaffold appears to be drilling a hole through a boiler shell without the little formality of removing the lagging. Ever seen it done?"

"No I never did, Highball. Possibly you don't understand. That is just another way of attracting attention. Possibly, you, as a shop man would glance at that ad and see nothing unusual if a man were drilling a hole in the boiler in the every-day manner, but you see something here that is unusual. It excited your curiosity. The advertiser secures your interest by showing something unusual, although unreal. As a consequence you read the advertising matter. I don't entirely agree with the practice. My shop training, like yours, causes me to accept the advertisement with more or less of a jolt. However, I have known cases where the advertiser's attention has been called to errors of this kind, and the matter explained just as I

have explained it to you. Possibly, if the readers were not too practical shop men, they would accept the lesson in a different manner."

"If the readers were not practical shop men, Bill, they would never know the difference. If they don't know the difference, what advantage would there be in using a wrong illustration? If they do know the difference, and I believe that most of the readers of this advertisement do know the difference, it creates an unfavorable impression. Boiled down to a single question, where is the advantage?

"While I am not any too well informed in regard to train operation, I would say that the locomotive and passenger train in this illustration for double-track operation, appears to be running against traffic. Then if you consider the wording of the advertising 'Safe train operation, etc.' you and I must agree that either the train is headed in the wrong direction for safe operation or else we have a lot to learn about railroads.

"This page, that urges us to save fuel and offers to show us how it may be accomplished by use of this particular equipment, also shows a train in motion. Do you notice, Bill, that the tender is loaded to the last lump with coal. If this were illustrating a real condition, we would agree that a tender that carried this amount of coal while on its way down the line was badly overloaded. The lesson I take from this is that the first step in saving fuel is to load tenders properly and not to spill coal along the right of way. Aside from being a wasteful practice it is more or less dangerous to Dominic, Guiseppi, and Pete, who are the landscape artists entrusted with the care of the tracks. After we have that lesson thoroughly learned, we might consider the use of our friend's device as a farther step in fuel economy."

"Yes, I believe you are right, Highball. That reminds me of a picture I once saw used to illustrate the virtues of 'Stickem's belt dressing.' I was horrified to see that the planer used as a subject for the illustration had the cross rail a foot or so above the job, and I also noticed that the gap was bridged by a tool slide run out beyond its normal position, while a feeble looking tool shank was doing its best to cover the remainder of the aching void. I promptly decided that if 'Stickem's belt dressing' would do 30 per cent of what it's maker claimed for it, that something was going to happen in the neighborhood of that planer once the tool got it's nose buried in a respectable cut on the surface of the job. The reason for all this was that the planer shown in the illustration was the planer our company handled. To that belt-dressing company, a belt was a belt and nothing more. Their interest began and ended in the belt alone."

A Comparison Made

"Does make a difference, doesn't it, Bill, when you put the shoe on the other foot? I will bet you that an advertisement of that kind wouldn't please you or any other progressive machine-tool man in the least, and if you were buying belt dressing, you would look on that advertisement with the same suspicion that I did this one showing the locomotive buried under a lot of I. C. C. defects in the way of steam leaks.

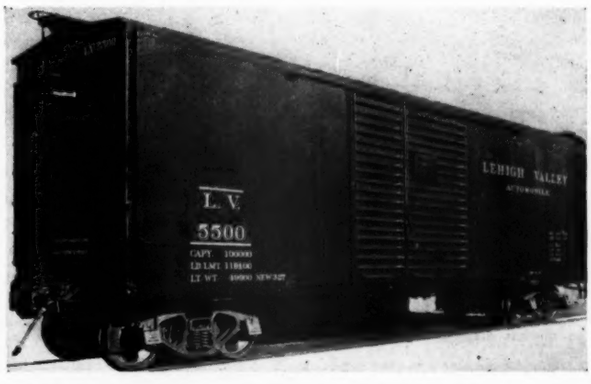
"Getting away from railroad advertising, I wonder if you ever looked at some of the high grade weekly magazines that get a gold-mounted rate for their advertising space. Do they work that space to the fullest extent? You may be assured they do. Take for example an automobile advertisement. Quite frequently you will see a true illustration of the automobile itself. The attractive appearance of the automobile is farther enhanced by the addition of a good-looking girl and a well-dressed man. The background shows throngs of people in their holiday attire, or the setting may be a picnic party, or again it may be so arranged as to bring to mind a home-coming party for some holiday occasion, but all in all you will scrutinize these pictures mighty close and not find a discordant or improbable feature in the whole picture. Here is a case where there is substantial evidence that the people paying for the space, read their own advertising.

"I have gotten quite a load off my chest concerning the pecularities of the advertising man. Possibly my viewpoint is all wrong, but if I were preparing advertising, either for nursery products or for railroad equipment, I would always endeavor to make things appear real. I would stick to my text. It is more important that I tell how many rivets per hour can be driven with my pneumatic hammer, than it is that I tell the size of the locomotives in which the rivets were driven. Incidentally it might be well for me to mention the reason why my particular hammer will perform in so creditable a manner.

"It might be advantageous for a concern selling drills, reamers, or cutters, if we may consider those items to illustrate our point, to omit the locomotive picture and use that valuable space in giving a few words of advice on how to get the best results from their product. Consider this booklet Blank & Blank put out as a model. They not only caution about setting up work, or mounting and grinding cutters, but go farther by telling what grade and grit to select in the grinding wheel used to resharpen their cutters. Then, to clinch the story, they show how a wrongly-ground cutter looks under a microscope. The tack in the end of the paddle is that this particular cutter was good for only 25 per cent of what it produced before it was misused in grinding. Their cutters might look the same, in the advertising space, as any other cutters, but I believe that the suggestions would serve to fix in the minds of the reader that Blank & Blank make good tools, and hand out valuable advice free with their advertising.

"I was first won over to Blank & Blank tools by the make-up and contents of their booklets. Their tools are on a par with their printed matter—first class in both cases. The shop men do not always see the catalogues or pamphlets, but many of them do read trade journals. Consider the mechanical side when preparing a mechanical ad. Anything put over that helps the man in the shop won't hurt the manufacturer."

* * *



Lehigh Valley all-steel automobile car built by the American Car & Foundry Company

The Characteristics of Injectors*

The utility of exhaust-steam injectors as locomotive feedwater heaters

By R. M. Osterman
Vice-President, The Superheater Company, Chicago

Part I

SINCE the preheating of water fed to locomotive boilers by exhaust steam has become more fully recognized on American railroads and since apparatus designed for that purpose is being applied in increasing quantities in this country, it may be of interest to review the possibilities of injectors, and particularly injectors working with exhaust-steam pressures—so-called exhaust-steam injectors—which have found considerable use on European locomotives, but which have more recently had the attention also of American railroads.

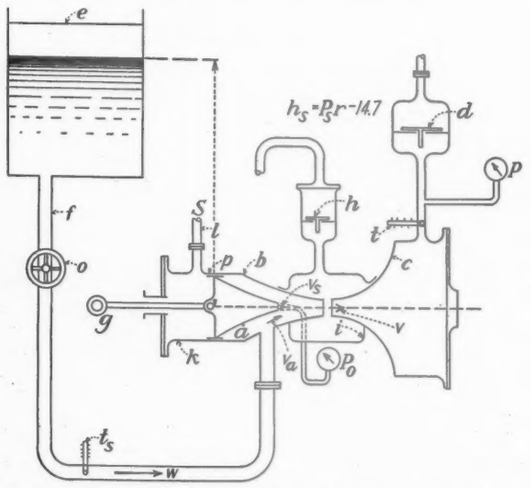


Fig. 1—Diagram of single-stage injector of simple type

The Injector Phenomenon

All calculations of injector performance must start from the following fundamental equations[1]:

$$W(t_s - 32) + \frac{r}{L}(P_s - P_o)W + SH = (W + S)(t - 32) + (W + S)\frac{r}{L}(P - P_o) \quad \ldots\ldots (1)$$

$$(W \times v_a + S \times v_s)C = (W + S)v \quad \ldots\ldots (2)$$

Where

W = weight of water flowing into injector in pounds per hour
t_s = temperature of suction water in degrees fahrenheit
r = height in feet of column of water corresponding to 1 lb. pressure per square inch
L = mechanical heat equivalent, equal to 778 ft.-lb. per sec. per B.t.u.
S = weight of steam in pounds per hour
P_s = absolute pressure of suction water due to static head
P_o = absolute pressure of suction water in condensation zone
P = absolute pressure of delivery water
v_a = velocity in feet per second of suction water when entering condensation zone
v_s = velocity in feet per second of steam having adiabatically expanded to the condensation pressure
v = velocity in feet per second of water at entrance to delivery nozzle
C = coefficient of friction and impact
H = heat in B.t.u. above 32 deg. contained in 1 lb. of operating steam

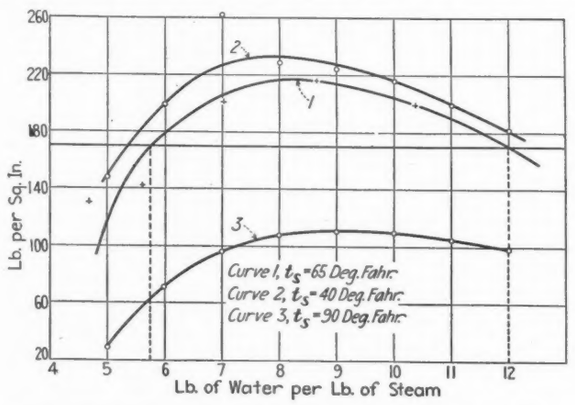


Fig. 2—Delivery pressure (gage) *P* as a function of ratio of water to steam—Operating steam pressure 135 lb. abs.

Equation (1) states that the sum of the heat contained in the suction water, the heat equivalent of its mechanical energy in entering the combining nozzle or the condensation zone, and the heat contained in the operating steam must be equivalent to the heat of the mixture plus its mechanical energy. With the assumption contained herein that radiation losses are negligible, the thermal efficiency of the apparatus is 100 per cent.

Equation (2) gives expression to the fact that the momentum of the entering water plus the momentum of the steam gained through expansion is equal to the momentum of the mixture, taking into consideration the fact that part of the momentum is destroyed by impact and friction.

Fig. 1, showing a simple type of single-stage injector in diagrammatic fashion, may be helpful in concentrating on the underlying physical phenomenon. The injector consists of a chamber *k* having a nozzle-shaped outlet *b*. Operating steam is admitted through pipe *l* and water through pipe *f* from the supply tank *e* and through opened valve *o*. A nozzle *a* slides within chamber *k* and is packed against its cylindrical walls at *p*. Its position can be shifted with handle *g*, and therewith the annular opening between nozzles *a* and *b* can be altered, which determines the water supply. Condensation takes place within *b* ahead of nozzle *a*, and the mixture enters the delivery tube *c* with the velocity *v*, which later is converted into pressure *P*. The water then flows at that pressure through check *d* into the feed pipe. The gap between the combining and delivery nozzles is seen to be encased in chamber

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*Abstract of paper and discussion presented by the Railroad Division at the annual meeting of the American Society of Mechanical Engineers, New York, December 3 to 7, 1928.

[1] The following text references were given in the first part of Mr. Osterman's paper: "Practice and Theory of the Injector," by Strickland E. Kneass, John Wiley & Sons, 1910; and "Injectors, Their Theory, Construction, and Working," by W. W. F. Pullen, Technical Publishing Co., Ltd., Manchester, 1906.

i, which is connected through an overflow and check valve *h* with the atmosphere.

Upon opening the water valve *o*, the combining nozzle *b* and the overflow chamber *i*, as well as the delivery nozzle *c*, will be filled with water under the pressure of the static suction head h^s, causing a free outflow of water through check valve *h*, and causing it to rise through check *d* to the level in the supply tank. When steam is admitted through pipe *l*, and when nozzle *a* has been shifted into a certain position with relation to the stationary nozzle *b*, the momentum of the condensing steam is sufficient to entrain the quantity of water admitted, the injector primes, and the mixture enters

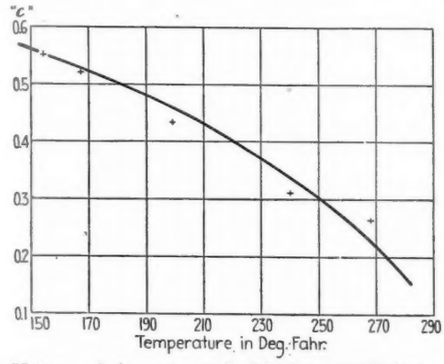

Fig. 3—Value of impact and friction coefficient *C* as a function of delivery temperature *t*
From Kneass, "Practice and Theory of the Injector."

the delivery nozzle with a great enough velocity *v* to start a continuous flow against the prevailing boiler pressure. Injector action is established owing to heat transfer between the steam and water, which makes the steam condense, and which causes a vacuum region ahead of the mouth of the steam nozzle and within the fluid body in the combining nozzle.

The shape of the nozzles and their relative position to each other are factors that largely govern the degree of perfection with which the momentum of steam and water can be combined under otherwise similar conditions. The amount of operating steam pressure available, the quantity and temperature of the suction water, as well as the head under which it reaches the

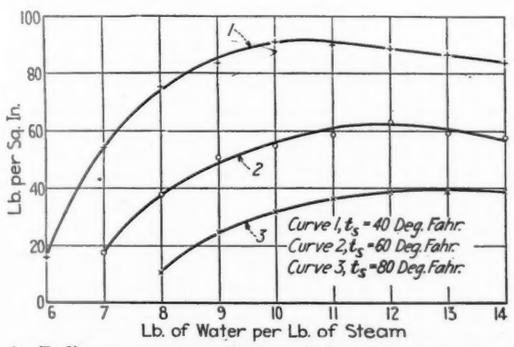

Fig. 4—Delivery-pressure characteristic of the simplest type of injector working with 1-lb. gage pressure and varying water temperature

injector, are all quantities that enter into the phenomenon as they affect the facilities for condensation and the gain of kinetic energy through expansion. The finish of the nozzles, or the manufacturing excellence, is another variable, because it affects the frictional losses.

Attempts have been made to determine the shapes of combining nozzles mathematically, on the basis of physical laws of heat transfer between steam jet and water jet applying to condenser practice, but nearly all progress in the design of injectors as a whole has been the result of laborious experimentation which yielded to the experimenters certain empirical data, on the basis of which injectors of various capacities and for various duties were designed.

General Injector Characteristics

Referring to Fig. 2, a delivery pressure of about 170 lb. is the highest that can be allowed in order to obtain a regulation of water quantity of 50 per cent; that is to say, from 6 lb. to 12 lb. of water per pound of steam. The highest mechanical efficiency, or what is nearly proportional thereto the highest pumping output per B.t.u. steam input, is then also essential for obtaining ample enough regulation.

The pumping ability of an injector and its feeding limits also depend, as previously mentioned, upon the temperature of the suction water, and in order to illustrate that influence other curves were added to Fig. 2 which were calculated with the help of experimental data in Kneass' book. Curve 2 applies to a suction-water temperature of 40 deg. F. and curve 3 to one of 90 deg. F. In calculating these curves the same coefficient *C* (see equation [2]), which Kneass found in his experiments with 65 deg. water, and which are shown in Fig. 3 as the function of delivery temperatures obtained, were used. *C*, as already explained, represents the ratio of the delivered momentum of an injector as compared with the one of an ideal injector when both carry a comparable condensing load which latter must be approximately proportional to the deliv-

Table I—Experimental and Calculated Values for Determining Injector Performance—The Results Are Plotted in Fig. 2

1	2	3	4	5	6	7	8
			Pv		*vs*		P_1
t_s	*W*	*t*	lb. per	*H—Hv*	ft. per		lb. per sq. in.
deg. fahr.	*S*	deg. fahr.	sq. in. abs.	B.t.u.	sec.	*C*	gage
40	5	237.0	23.7	132	2550	0.355	148.0
40	6	209.0	14.0	162	2855	0.430	199.0
40	7	178.0	7.2	206	3205	0.500	262.0
40	8	171.5	6.1	213	3275	0.515	228.0
40	9	158.3	4.5	231	3400	0.545	224.0
40	10	147.5	3.5	246	3515	0.570	216.0
40	11	139.0	2.9	256	3590	0.585	199.0
40	12	131.0	2.6	264	3620	0.600	181.0
90	5	279.0	48.0	79	1990	0.200	28.5
90	6	252.0	31.0	111	2360	0.310	71.0
90	7	232.0	22.0	136	2615	0.370	96.0
90	8	216.0	16.0	156	2795	0.415	107.0
90	9	203.3	12.3	171	2930	0.445	110.0
90	10	193.0	10.0	183	3030	0.470	109.0
90	11	184.5	8.2	196	3140	0.485	105.0
90	12	177.5	7.1	206	3200	0.500	98.5

ery temperature of the mixture. In calculating curves 2 and 3 of Fig. 2, the same values *C* were taken from curve 3 that were obtained by Kneass in his experiments for the same delivery temperatures. Further, in using equation [2] for the calculation of the momenta, the quantity $W \times v_a$, being the momentum of the suction water within the combining tube, has been neglected; to compensate for that error, however, the momentum required to force the mixture from the condensate pressure *Po* to atmosphere has likewise been neglected, so that *v* was assumed to determine the gage pressure at delivery P^1, the equation [2] then becoming simplified in the following manner:

$$S \times v_s \times C = (W + S)v$$

With *r* equal to 2.4, we have

$$v_s \times C = 12.4\ P_1 \left(1 + \frac{W}{S}\right) \quad \text{.....[2a]}$$

The v_s in equation [2a] was determined as the velocity of adiabatic expansion from 135 lb. absolute to the saturation pressure *Pv*, which corresponds to the

temperature of the mixture t, and the latter was evaluated from the following simplified equation:

$$W/S\ (t_s - 32) + H = (1 + W/S)\ (t - 32) \quad \text{.....[1a]}$$

With the knowledge of Pv, v_s was found from a Mollier diagram as

$$2g\sqrt{(H - Hv)} = 778$$

where Hv = heat in 1 lb. of steam above 32 deg. F. corresponding to pressure Pv. All experimental and calculated values are to be found in Table I.

It must be stated again that the assumptions underlying the determination of v_s do not coincide with probable physical facts, because the expansion may not be truly adiabatic; neither is it true that all the steam is condensed at an average pressure equal to the saturation pressure which corresponds to the final temperature of the mixture, but inasmuch as the coefficient C has been established as a quality factor which is equal to one in the best possible injector working under generally similar conditions, curves 1, 2, and 3 are quite sufficient for illustrating the influence of suction water temperature upon the pumping power of an injector.

Table II—Values for Determining the Performance of Exhaust-Steam Injectors—The Results Are Plotted in Fig. 4

1	2	3	4	5	6	7	8
t_s	$\frac{W}{S}$	t	Pv lb. per sq. in. abs.	H—Hv B.t.u.	vs ft. per sec.	C	P_1 lb. per sq. in.
40	6	203.2	12.3	12	773	0.443	15.1
40	7	182.8	8.0	45	1499	0.488	54.3
40	8	166.9	5.6	68	1842	0.523	74.9
40	9	154.3	4.1	87	2065	0.547	83.2
40	10	143.9	3.2	105	2290	0.567	90.7
40	11	138.2	2.7	116	2408	0.585	89.4
40	12	127.9	2.1	129	2535	0.600	88.9
40	13	121.6	1.8	137	2625	0.615	86.6
40	14	116.2	1.5	147	2700	0.630	83.5
60	6	210.3	...	...	...	...	...
60	7	201.5	11.9	17	923	0.447	17.4
60	8	184.7	8.3	40	1411	0.484	37.5
60	9	172.3	6.4	59	1719	0.512	50.3
60	10	164.1	5.2	73	1913	0.529	54.9
60	11	153.5	4.1	87	2065	0.553	58.6
60	12	146.3	3.4	101	2250	0.565	62.2
60	13	140.2	2.9	109	2330	0.575	59.5
60	14	134.8	2.6	115	2395	0.590	57.5
80	7	217.8	...	...	...	...	...
80	8	203.5	12.5	13	809	0.443	10.1
80	9	190.3	9.4	34	1304	0.468	24.2
80	10	180.2	7.6	48	1551	0.494	31.5
80	11	171.9	6.3	61	1745	0.514	36.3
80	12	164.8	5.3	71	1885	0.528	38.2
80	13	158.8	4.6	79	1985	0.545	38.8
80	14	153.5	4.0	88	2095	0.553	38.7

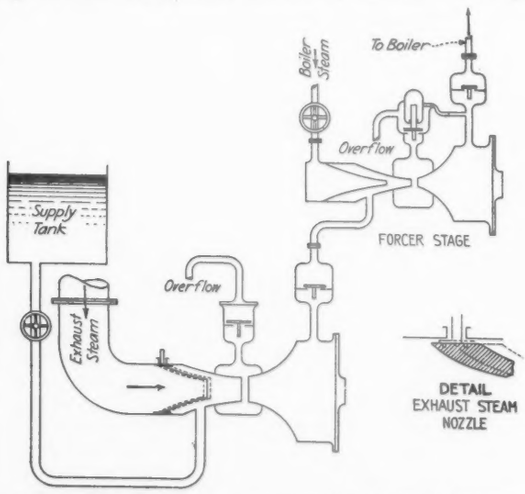

Fig. 5—Diagram of a compound exhaust injector—Two overflows are provided

Exhaust-Steam Injector Characteristics

Injectors which receive their steam supply from the exhaust of locomotives have to work with operating steam pressures of as low as 1 lb. Consequently, the value v_s in equation (2), being the velocity which the steam attains in adiabatically expanding to the condensation pressure, is only a fraction of one that is attained in injectors working with steam of boiler pressure. The impossibility of maintaining the value of v_s in equation (2) at a high enough figure, or to obtain a sufficient steam momentum, has been the stumbling block in the adaptation of the injector principle in exhaust-steam-injector feedwater heaters on locomotives or other steam plants, coupled with the fact that coefficient C containing the influence of rapid condensation capacity could not be made higher to compensate for the loss in v_s; rather the more unfavorable ratio of the condensing surface of the steam jet to its cross-sectional area, which is obtained in low-pressure injectors as a result of the much larger steam nozzles required actually tends to make condensation more difficult. Assuming for purposes of relative illustration that the factors C obtaining in an exhaust-steam-injector were as high as the ones obtained in an injector working with higher pressures, and using the values of C from Fig. 2, Table II was calculated in the same manner as Table I, and the results are plotted in Fig. 4.

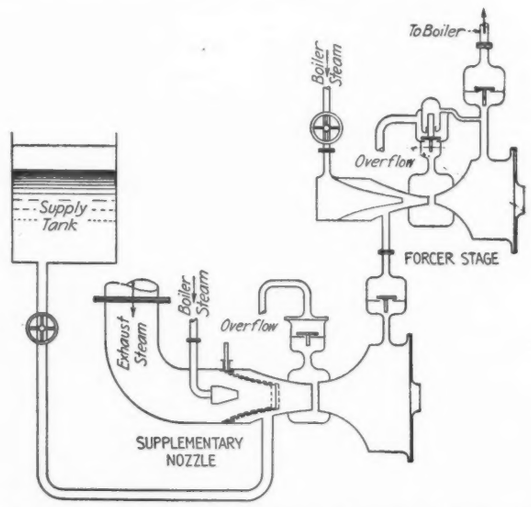

Fig. 6—Diagram of a compound exhaust injector with small supplementary steam nozzle added

These curves, then represent the very highest possible pressures against which a single stage injector, similar to the one shown diagrammatically in Fig. 1, could work with a pressure of 1 lb. It is evident that in order to utilize such a single stage exhaust-steam-injector under conditions of modern boiler pressures at all, means for boosting the delivery pressures have to be provided. As a matter of fact, steps were taken by English manufacturers many years ago to increase delivery pressures of exhaust steam injectors by compounding; i.e., the addition of a second or so-called forcer stage, the suction of which was coupled on to the delivery end of the exhaust steam stage and which operated with steam of boiler pressure. Fig. 5 shows such a compound exhaust injector diagrammatically, and its working will be readily understood with the explanations formerly given. Two overflows were provided, and the proportions were such that the overflow pressure in the exhaust-steam stage never exceeded the atmospheric, making it possible to seal this overflow chamber with an ordinary check; whereas the overflow in the forcer stage, having always a pressure above

the atmospheric had to be either locked by hand or, as shown in the diagram, by the delivery pressure itself, which latter arrangement made the injector relatively easy of operation. In another design shown diagrammatically in Fig. 6 the arrangement was substantially the same except that a small supplementary steam nozzle within, and concentric with the exhaust steam nozzle was added, for the purpose of obtaining higher delivery pressures from the preheating stage, and to thus increase the range of the forcer stage and of the injector as a whole.

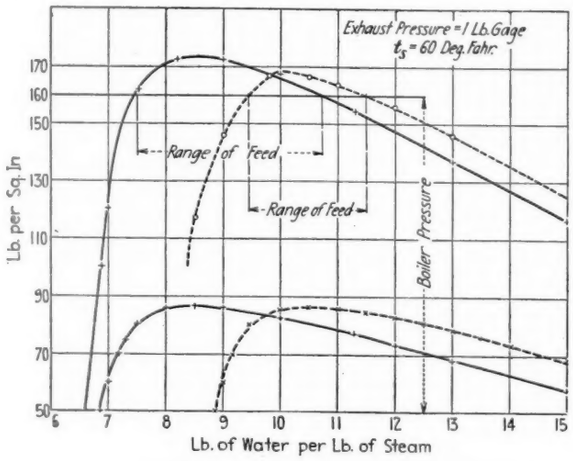

Fig. 7—Pressure characteristic of the compound exhaust-steam injector

Calculated from Pullen, "Injectors, Their Theory, Construction and Working."

It should be here remembered that the range of feed of an injector is entirely governed by its surplus of kinetic energy when working with the most favorable ratio of water to steam, and that the greatest surplus is obtained for mixtures the temperature of which is low enough to allow the operating steam to gain the greatest momentum. Thus the momentum produced in the forcer stage will fluctuate with the amount of water fed to it in an already well-preheated condition far more than would the momentum produced in the same injector stage were it fed with cooler water. On the other hand, the water preheated in the low-pressure stage has already a momentum imparted to it and arrives at the forcer stage under a pressure, so that the forcer stage only makes up the balance. Still it is important for the proper working of such a combination that the pressure characteristics of both stages be similar and stay similar functions of W/S, as otherwise stability over a range of feeds can be maintained only through adjustment of the steam supply to the forcer stage. Fig. 7 illustrates the point. The full-line curves are the part-pressure characteristics of both stages assumed to be alike and superimposed; also the resulting total-pressure characteristic. The dotted lines are the partial-pressure characteristics shifted with relation to each other and the resulting total-pressure characteristic. It is readily seen that for an assumed boiler pressure the range of feed becomes smaller as the partial characteristics become different functions of the ratio W/S.

In locomotive operation rapid and unforeseen changes of exhaust pressure are a common occurrence; consequently with compound injectors consisting of fixed nozzle stages the ratios of water to steam will, for a given admission of water to the low-pressure stage, undergo rapid changes, and the partial-pressure characteristics will become different functions of the ratio W/S unless the admission of live steam to the forcer stage is altered in conformance with the change of exhaust steam flow—which is difficult in practice.

In Fig. 7 it has been assumed that whereas each one of the two stages produced about 87 lb. of pressure, or a total of 174 lb. when both work with the most favorable ratio W/S equal to 8½, the pressure which the exhaust-steam stage contributes, when its W/S becomes 6½, is only about 30 lb., or that the total available delivery pressure will under those circumstances decrease to 117 lb., which is not sufficient to feed against the assumed boiler pressure of 160 lb. If the exhaust stage was producing its maximum pressure with 1 lb. of exhaust steam, for instance, a rise of the exhaust pressure to 5 lb. would just about produce a change of that magnitude in the ratio W/S. The pressure characteristics used in Fig. 7 are calculated theoretical curves taken from Pullen's book and are found in the chapter on exhaust steam injectors for an exhaust pressure of 1 lb. gage and 60 deg. F. suction water. A factor C of 0.5 has been applied to reduce the theoretical pressures to the ones that may properly be expected to be obtained in practice.

The higher the suction-water temperature is initially, and the lower therefore, the range of partial pressures of the exhaust-steam stage, the more disturbing will be the effect of the fluctuating exhaust pressures and the loss of similarity of partial-pressure characteristics.

As a matter of fact, the manipulation of compound exhaust-steam injectors proved to be so bothersome

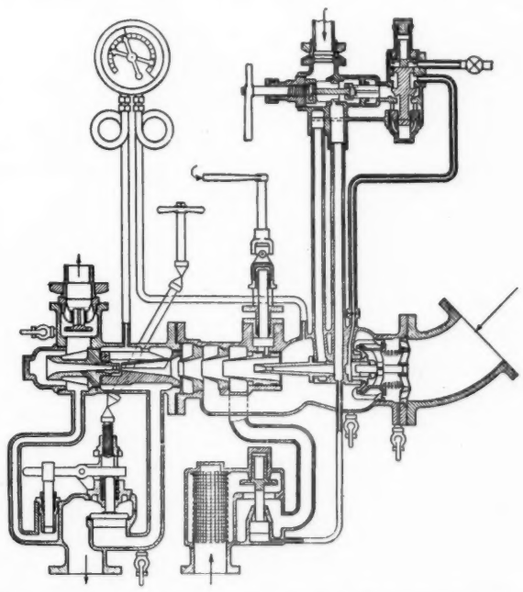

Fig. 8—Exhaust-steam injector adapted to American locomotive practice

on English locomotives that their use was largely abandoned.

If the duty of the exhaust-steam stage is purposely decreased and its share of the required total-delivery pressure reduced—which can be accomplished through the installation of relatively small exhaust steam nozzles, and by thereby increasing the values of W/S (in which case the action of the forcer stage is intensified) or if that should not be possible, by the installation of the supplementary nozzle, already referred to, in the

exhaust steam stage itself—the action of a compound injector, can be somewhat stabilized. However, only at the expense of the reclamation of exhaust steam or by reducing the value of the apparatus as a feedwater heater.

An examination of the pressure characteristics of injectors working with higher steam pressures (Fig. 2) reveals that their power decreases very much more rapidly with decreasing values of W/S than with increasing ones. This is owing to the fact that with decreasing W, (S being the same throughout the range of an injector with constant steam-nozzle and operating-steam pressure) the product $S \times v_s \times C$ which, in the high-pressure injector, is responsible for by far the greatest proportion of the resulting momentum, decreases very fast, because v_s decreases as the square

Table III—Values of t_s, t and P_1 Obtained from Tests of a No. 10 Elesco injector

Exhaust pressure, lb. gage	H B.t.u.	t_s deg. fahr.	t deg. fahr.	W/S	P_1 gage lb. per sq. in.	P_v lb. per sq. in. abs.	$H—H_v$ B.t.u.	v_s ft. per sec.	C
1	1151	40	146	9.78	168	3.40	100	2230	0.777
3	1154	40	152	9.23	185	3.95	103	2265	0.764
5	1157	40	160	8.57	200	4.74	98	2205	0.760
10	1160	40	178	7.35	235	7.35	87	2080	0.763
15	1163	40	186	6.91	270	8.50	86	2070	0.912
1	1151	50	150	10.33	160	4.74	80	1950	0.912
5	1157	50	160	9.35	185	4.79	98	2210	0.790
10	1160	50	173	8.30	222	6.45	95	2175	0.790
15	1163	50	185	7.47	262	8.40	86	2070	0.820
20	1164	50	198	6.74	280	11.00	81	2050	0.784
1	1151	60	160	10.25	148	4.79	79	1980	0.858
5	1157	60	170	9.26	175	6.00	78	1970	0.853
10	1160	60	180	8.44	210	7.20	88	2090	0.812
15	1163	60	196	7.34	235	10.80	76	1945	0.815
20	1164	60	198	7.23	250	11.00	81	2050	0.787
1	1151	70	171	10.20	130	6.10	62	1756	0.902
5	1157	70	182	8.90	155	7.90	63	1770	0.867
10	1160	70	192	8.20	185	9.80	66	1810	0.857
15	1163	70	190	8.30	210	9.70	78	1870	0.894
20	1164	70	210	7.04	230	14.10	66	1810	0.835
1	1151	80	180	10.03	115	7.20	52	1610	0.910
5	1157	80	190	9.00	132	9.70	50	1575	0.905
10	1160	80	203	8.04	160	12.20	50	1575	0.900
15	1163	80	216	7.20	165	16.00	44	1480	0.884

root of the available energy of expansion, which latter again becomes rapidly smaller with a rising temperature of the mixture and the rise of P_v.

In injectors working with exhaust pressures the tendency toward a rapid decrease of delivery pressures with decreasing ratios of W/S is still more emphasized. On the one hand, the other product on the left side of equation [2]—i.e., $W \times v_s \times C$—is relied upon to contribute a larger share of the resulting momentum, and it decreases faster than W itself; on the other hand, S is, in the exhaust steam injector, not constant throughout its range of operation. The steam flow through a nozzel maintains itself at the maximum only as long as the counter pressure at the mouth of the nozzle is lower than the critical pressure equal to 57 per cent of the operating pressure. This is always the case in high-pressure injectors, but not necessarily so in low-pressure machines. With 1 lb. gage, or 15.7 lb. abs. operating pressure, the maximum steam flow through the steam nozzle is not going to be obtained unless P_v is lower than about 9 lb. abs., and is not always possible to so limit the working range of an injector.

By similar reasoning one must arrive at the conclusion that instability of operating steam pressure is, with a given fixed size of steam nozzle, very much more disturbing to the lower-pressure injector than to the instrument working with steam of boiler pressure, a difficulty touched upon in the graphical illustration of Fig. 7, which is meant to explain the inherent difficulties of compound exhaust-steam injectors arising out of the adjustment of the quantity of water handled.

While the inherent insufficiency of pumping power and the resulting lack of regulation cannot be eliminated without somehow increasing the utilization of the steam's expansion power, the disturbing influence of widely varying operating pressures can be remedied by automatic pressure-regulating means; and one American firm of manufacturers when reviving the idea of the compound exhaust-steam injector embodied such automatic exhaust-steam regulation in the design of its machines.

Preheating the tank water with exhaust steam or mixture, and controlling by thermostatic means the maximum preheating temperature, with the intention of pumping the preheated water with a relatively efficient live-steam compound injector into the boiler, has been tried as a means of exhaust-steam reclamation, but little has become known of the results that were obtained.

Some railroads, in an effort to solve the exhaust-steam-injector problem, have also tried preheating the water in the tender by exhaust steam, with and without thermostatic regulation, and they have endeavored to handle the thus preheated water into the boiler with relatively efficient compound live-steam injectors.

All of the exhaust-steam-injector combinations mentioned are handicapped in range and stability because of the inherently small momentum which an ordinary injector when operated with a very low steam pressure is able to impart to the water and because of the necessity to boost its action by a secondary nozzel combination fed with steam of higher pressure the characteristic of which does not automatically correlate itself to the one of the low-pressure-stage characteristic with fluctuations of exhaust-steam pressure or water quantities handled. The smaller the momentum of the low-pressure jet or the lower the pressure that the exhaust-steam stage can produce, the greater has to be the momentum or pressure contributed by any booster or forcer stage, and the more pronounced will be the lack of automatic correlation of the two stages.

No mention has been made so far of fluctuations in the quality of the exhaust steam, which on a locomotive may be very considerable. Even if it were possible

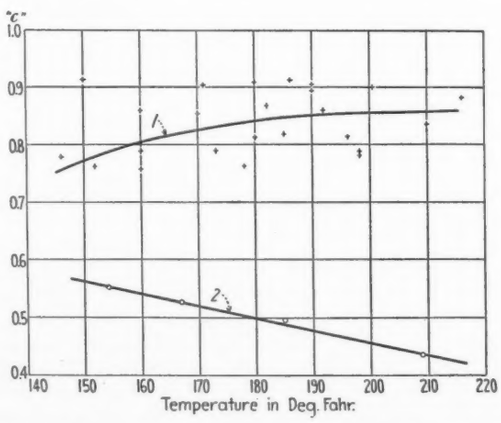

Fig. 9—Values of impact and friction coefficient C as a function of delivery temperature t

by mechanical means to keep the exhaust pressure from fluctuating, the number of heat units passing through an exhaust-steam nozzle of fixed size would vary somewhat with the operating conditions of the locomotive and therewith the equivalent ratio W/S.

If the manufacturers of so-called live-steam injectors

strove for highest pumping effect, so that they might minimize the amount of steam used and so that they might work with large ratios of water to steam, the designers of exhaust-steam injectors have every reason to strive for largest pumping power for the sake of obtaining sufficient stability with lowest ratios of water to steam, because the very object of the use of an exhaust steam injector is the condensation of as large a part of the available exhaust steam as possible, with a view to the greatest fuel and water saving. Inasmuch, then, as those proportions of water to steam which are most profitable from the feedwater heating point of view occur in that part of an injector's pressure characteristic where the pumping action is least stable, the task of producing a machine that is sufficiently flexible in its operation, and which yields a substantial feedwater-heating effect besides, seemed to be doubly difficult.

However, a great step in advance could be recorded in the history of exhaust-steam injector development when Davies & Metcalfe, Ltd., English manufacturers who had been identified with exhaust steam injector research since the very earliest days of the conception of the apparatus, succeeded in evolving a single-stage nozzle combination which yielded nearly twice the pumping power of single-pressure stages that had heretofore been used.

As now built, a delivery pressure of at least 146 lb. gage is being obtained with an operating steam pressure of 1 lb. and a suction water temperature of 60 deg. F. In order to boost the delivery pressure to the prevailing boiler pressures, a relatively small amount of boiler steam is required. Davies & Metcalf succeeded in superimposing this supplementary jet of steam upon their exhaust steam jet, to administer the former through a supplementary steam nozzle concentric with the main exhaust steam nozzle, and to condense the two steam jets in one combining nozzle without putting a prohibitive condensing load upon it, an arrangement similar to the one shown diagrammatically in Fig. 6. A longitudinal section of a Davies & Metcalfe exhaust steam injector with its auxiliary apparatus, as adapted to American locomotive practice and put on the American market by the Superheater Company under the trade name "Elesco," is shown in Fig. 8.

The advance in the art of designing exhaust steam injectors which Davies & Metcalfe made is, within the frame of this discussion, best illustrated by a comparison of the performance of an Elesco injector with that of a standard injector consisting of steam nozzle, combining nozzle, and delivery nozzle only. In Table III the values of t_s, t and P_1, which were obtained for certain exhaust steam pressures in the test of a No. 10 Elesco injector, are recorded. With these quantities established by test, the ratios W/S were then calculated with the help of the simplified equation [1*a*]. With the further assumption that the steam condensed at a pressure P_v (the saturation pressure corresponding to t) the values of P_v were established from the temperatures, the heat drop from adiabatic expansion was taken from a Mollier diagram the velocity of the expanding steam was calculated therefrom, and finally, with a knowledge of all these quantities, the coefficient C was calculated with the help of equation [2*a*] and placed into the last column of Table III.

It will be noted from Fig. 9, in which a plot of coefficient C as a function of t has been attempted, that no such very definite function could be established, but that the range of the values of coefficient C is considerably higher than the ones experimentally established by Kneass for an injector of simpler design and working with 135 lb. abs. pressure. The values of C from Kneass, which are presented in Fig. 3, and which formed the basis of the calculations heretofore presented, obtained for a wide range of the quantity W/S —so wide that the density of the jet, or the percentage of steam actually condensed in the combining nozzle, greatly varied. On the other hand, the coefficients C found for the Elesco injector apply, all of them, to the most favorable loads carried by the injector for a given exhaust-pressure and suction-water temperature—at which most favorable loads the complete or nearly complete condensation of the steam was undoubtedly obtained in the combining tube. Could the Elesco injector have been tested with a wider range of loads, and had the maximum density of the jet thus not been maintained, the factor C would undoubtedly have shown a declining tendency for the lower jet density also. The values of C as given in Fig. 9 for the Elesco injector are then really comparable only with the maximum value of C in Fig. 3.

It should here again be emphasized that the short-cut method of calculating the various quantities in Tables I and II on the assumption that all the steam expanded to P_v, the saturation pressure corresponding to the temperature of final mixture, was an approximation only. The assumption may nearly coincide with physical facts for jet densities equal to one only, at which density the highest delivery pressure should be obtained in a correctly proportioned injector. However, the curves plotted from Tables I and II had only the purpose of illustrating relative performances and of establishing the general character of the function between delivery pressure and load; they are not meant to represent the actual absolute values of the pumping power of a certain injector. We hope that the method of presentation will not be too much criticized.

(*To be continued in the March issue*)

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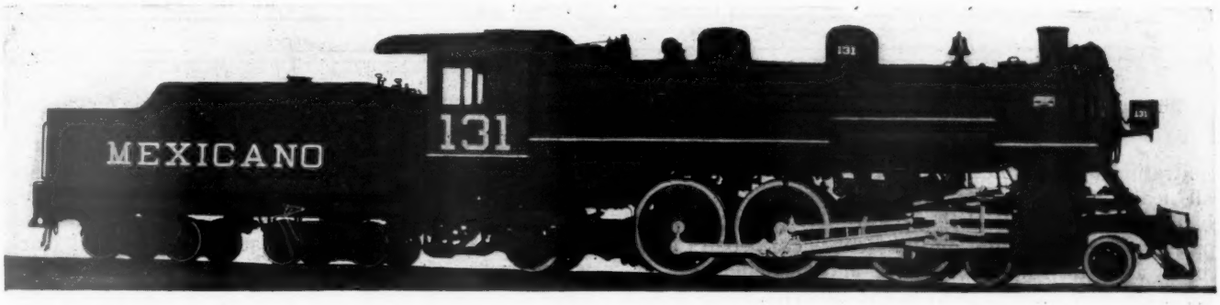
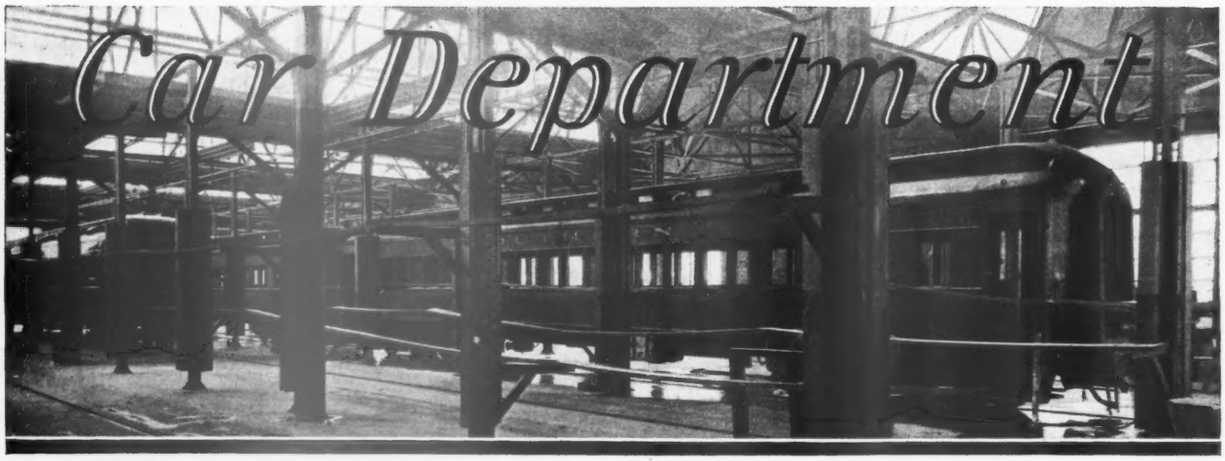


Three-cylinder 4-6-2 type locomotive built for the Mexican Railway Company by the American Locomotive Company Tractive force, 41,400 lb.

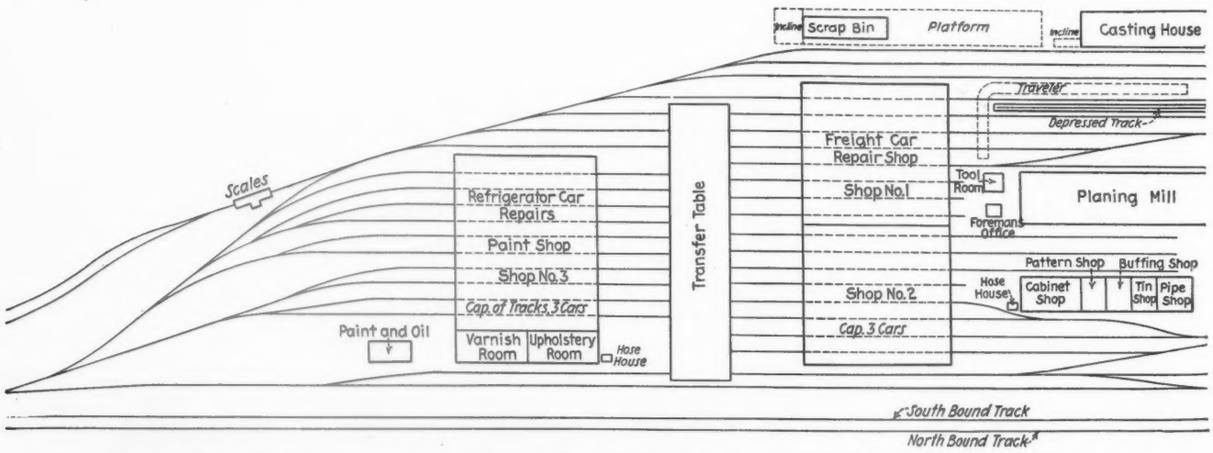


B. & M. Centralized Freight Car Repairs at Concord, N. H.

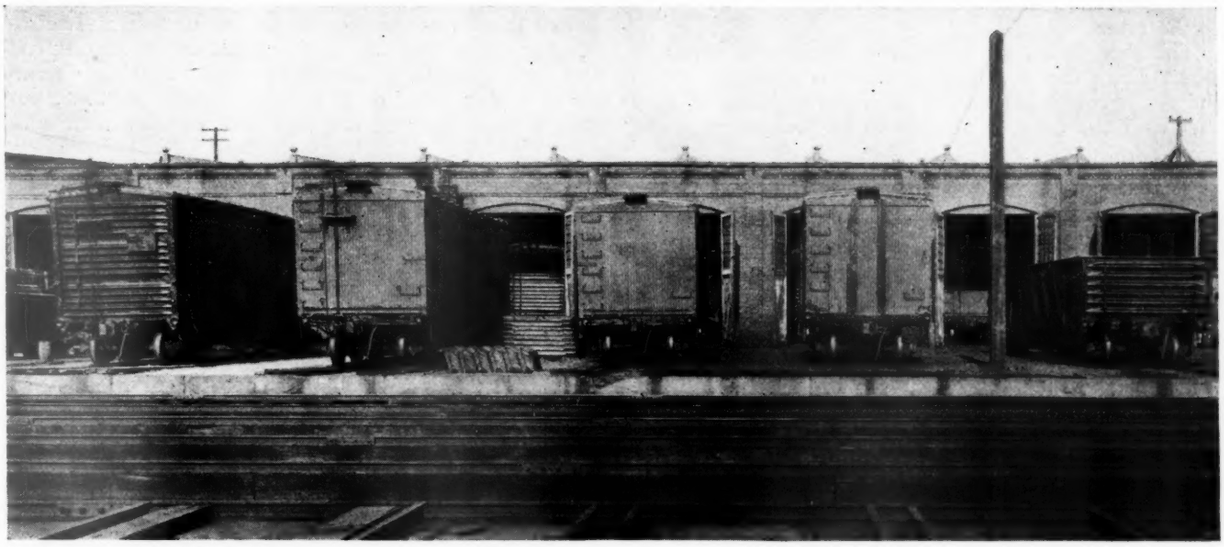
Progressive repair- and material-handling system largely responsible for average daily output of 32 cars

PRIOR to 1927, heavy freight car repairs on the Boston & Maine were concentrated at East Fritchburg, Mass, and Concord, N. H. In accordance with the general policy adopted by the B. & M. of concentrating maintenance work at strategic repair points, all heavy and general freight car repair work is now handled at the Concord shops. Formerly, locomotive repairs, as well as freight and passenger car repairs, were made at Concord. Locomotive and passenger-car repairs are now concentrated at the Billerica shops which leaves all of the facilities at Concord to be used for freight-car repairs.

Few changes were required to adopt the shops for freight-car repairs. The shops run directly north and south. Shop No. 4, which was formerly the locomotive repair shop, is located at the northend of the layout. All of the locomotive repair machinery was removed, two of the three tracks already in the shop were extended to connect with the lead track outside of the south end of the shop and an additional track, which passes through the shop and connects with the outside shifting track, has been placed along the east side of the shop. The shop now has a capacity for 33 cars. An elevated truck-repair track has been located



The south end of the yard which includes Shops Nos. 1, 2 and 3 with the transfer table between the two buildings



Car ready to be moved by tractor to positions Nos. 8 and 9

at the northwest corner of the shop. A five-ton traveling crane serves this track.

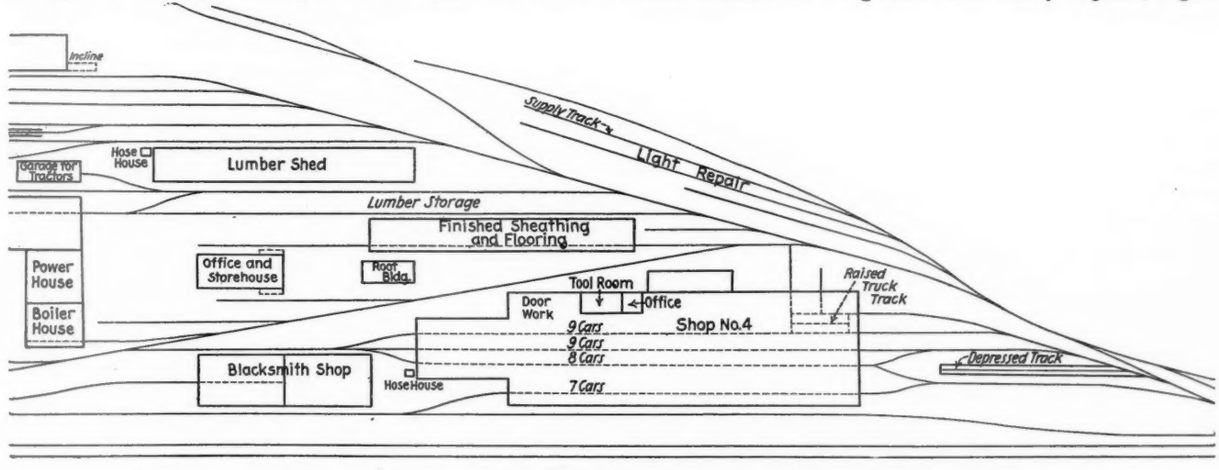
These are the principal changes that have been made to the shop layout. Several tracks have been connected with crossovers in order to facilitate the movement of the cars through the shops. Also, two depressed tracks for scrap material cars have been located at the two stripping stations. These tracks, which will hold two or more cars, have been depressed in a concrete basin. One track is located opposite the north end of shop No. 4, and the other track is located in the medium repair yard, situated along the west side of the shop yard. The transfer table has been extended to include two additional tracks. New scaffolding has been placed throughout the shops. Acetylene and oxygen for welding or cutting are distributed from a central generating station.

In shop No. 2, six tracks are used for painting cars and two tracks for caboose repairs. Shop No. 3, located south of the transfer table, contains ten three-car capacity tracks. Five tracks are used for stenciling and the remainder for repairing refrigerator cars. Shop No. 4 is devoted entirely to the repair of steel underframe box cars, some of which are equipped with metal ends.

Light and medium repairs are made on outside tracks. The light repair tracks are located in the north-western corner of the shop yard, while the medium repair tracks are located along the west side of the planing mill building.

The average daily output of these shops and repair tracks consists of 14 general and heavy repairs, eight medium repairs and ten light repairs. This output is obtained with a total force of 370 men, the allocation of whom is indicated in the organization chart illustrated. One hundred fifty-four men are assigned to shops Nos. 1, 2 and 3 and the outside medium repair tracks; 122 men to shop No. 4 and the light repair tracks, and 34 men each in the blacksmith shop and planing mill.

Box cars with steel underframes are passed through shop No. 4 under the progressive system of repairs.



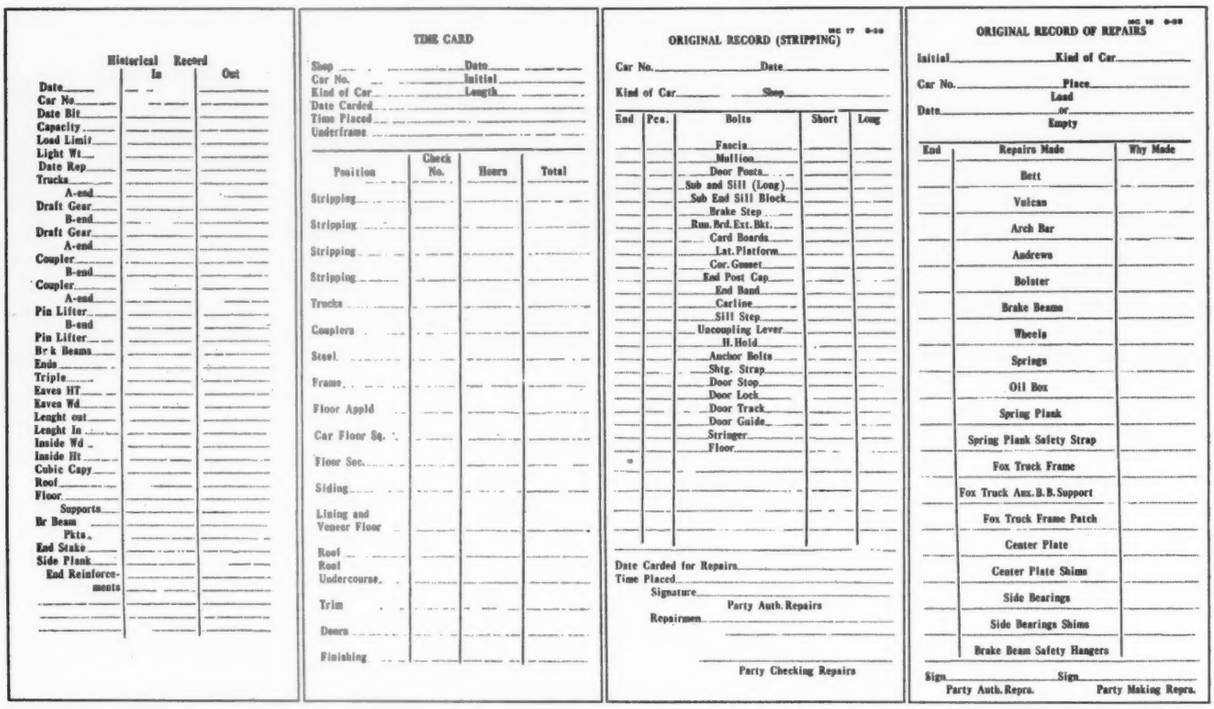
The north end of the yard layout which includes Shop No. 4 in which progressive repairs are made

What Repairs Are Made

Four departments are included in the three main shop buildings. The building north of the transfer table contains shops No. 1 and No. 2 in each of which are eight three-car capacity tracks. Repairs are made to wood and steel drop-bottom coal cars in shop No. 1.

The cars are moved through the shop from one station to the other.

The shop is set up to repair a designated series of cars. Each day a switching sheet is made up which shows the completed cars to be removed from the shop yard and the number of cars to be brought in. The foreman of each of the repair shops requests the number of cars he needs for the following day. A check is made each day of the number and class of cars awaiting shop. The switching lists are checked against the shopping list to determine whether there are sufficient cars on hand to meet the shop demand. If the number of cars of a certain series awaiting repairs gets low, the Boston office is requested to order more cars in for repairs.



A historical record and time card are made out for each car in for repairs—The third card is filled in at the stripping track and the last card on the right, when filled out, shows what repairs have been made to the trucks

Position No. 1, Stripper—The cars to be repaired are placed on the stripping tracks, which are located at the extreme north end of the shop enclosure. The stripping gang consists of 18 men, four removing the trim, two the roofs, two the sheathing, lining and floor, five removing metal parts, and five laborers, who handle reclaimed and scrapped material.

After the cars are placed, a stenciling record form, one of which is illustrated, is filled out and sent to the shop superintendent's office where it is kept until the car is ready for stenciling. The form is then returned to the car and on it are noted the inside measurements of the car, cubical capacity, and whether any additions or betterments have been made. The form is then left with the car for the guidance of the foreman painter and is returned by him to the office for file, after checking the car against all of the items listed on the card.

The stripping foreman and the inspector make the original inspection of the car, first removing all defect cards, if any, which are sent to the superintendent's office with information as to whether all of the defects are properly covered and if not, sufficient data is obtained to protect the interest of the B. & M. The inspector marks the car number and initial on all end and corner bands, all sheathing straps, which are numbered 1, 2, 3, etc., R. & L. After these parts are removed from the car, they are tied together with wire and sent to the position at which they will be reapplied. All brake staffs, hand holds, pin lifters, etc., are examined for breaks or undersize dimensions and then marked with different colored lumber crayon. Yellow indicates scrap material and red, material to be sent to the blacksmith shop for straightening or repair. Material that is not marked, is to be replaced on the car without further attention. These parts are taken care of by the laborers in the stripping gang.

All sheathing, lining and flooring that is to be removed is marked with yellow crayon. If the floor is to be veneered, it is indicated by chalk on the lining next to the door opening inside of the car. The disposition of roof material is indicated by the same method. The doors are marked either for scrapping or repairs. When the underframe is inspected, particular care is taken so that the car will be marked for stripping in such a manner that the steel work can be economically repaired. All of the defects found are noted on the various original repair cards illustrated, which are sent to the proper repair positions. A time card is placed with each car and remains with it until the car is ready for the paint shop.

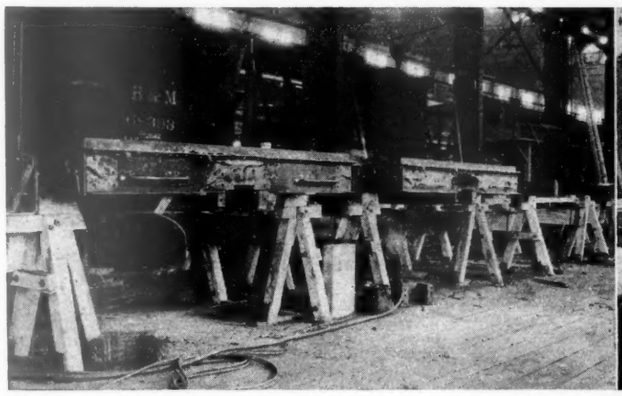
The stripping foreman must see that the cars are properly stripped. He must exercise good judgment as to the amount of repairs that should be made to the cars and see that the frame is properly secured and braced for safe movement into the shop. He must also see that the parts marked O.K. are put back on the car so that they will not interfere with the steel repairmen.

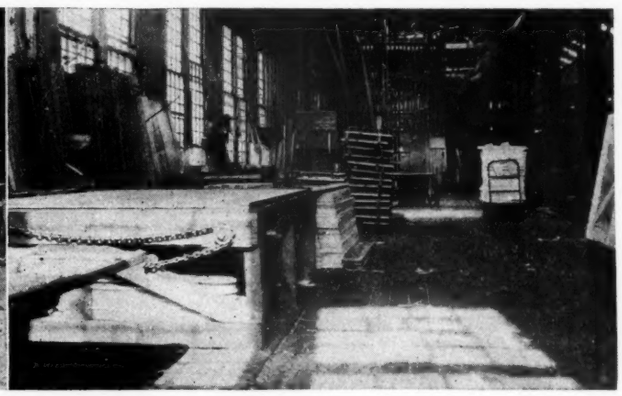
Position No. 2, Trucks—The cars are then moved into the shop to the steel position where the trucks are removed and sent to the truck-repair gang. This gang of six men consisting of two carmen, two carmen helpers, one oxy-acetylene operator and one laborer. The trucks are placed on a raised track where they are examined by the shop inspector. He marks all defective wheels, measures each dead and live lever to see that the proper ratio is maintained, measures the bottom rod to see that it is of the proper length for each class of truck, and examines all journal boxes, arch bars and truck sides for any visible fractures. He marks all parts to be scrapped with yellow crayon and parts for the blacksmith shop with red crayon. The foreman and the inspector watch the work until the truck is completed and ready to go back under the car.

Position No. 3, Steel work—This gang consists of 21 men divided as follows: Four car men and four helpers prepare the steel underframe for the riveting gang, which consists of four carmen and five helpers, two laborers who deliver material, and two laborers who keep the position clean.

The underframes are cut off back of the bolsters a sufficient distance to permit a standard A. R. A. splice to be made to permit straightening or renewal. The frames thus removed are taken to a gang of two men who rebuild them on jigs, such as shown in one of the illustrations. If the end frames are in good condition but contain only a slight bend, they are straightened on the car by the application of heat.

An inspector indicates on an original inspection card whether the parts should be renewed or removed and repaired. Where two parts are to be riveted together in assembling the underframe, the parts are painted. Painter helpers scrape off all loose paint and rust from the underframe. All 1¼ in. air-brake pipe work is done at this position by air-brake repairmen. After the underframe work is completed, the car is placed on its trucks.

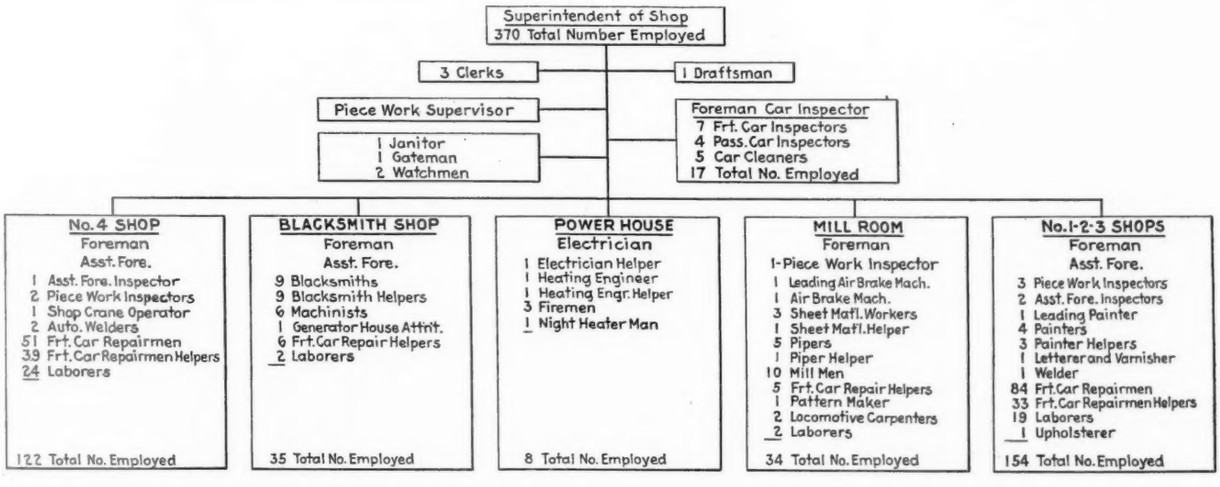




Left—The underframes which are cut off back of the bolster are repaired by a separate crew of carmen; Right—Doors, running boards, etc., are repaired at this position

Position No. 4, Framing, flooring and roof undercourse—This gang consists of 15 men—13 carmen and two material laborers. All framing repairs such as the renewal of floor stringers, post and braces, side and end plates, all cripple posts, belt rails, body tie rods, and the laying of the floor, is done in this position by carmen, who work in gangs of two each. The renewal of the roof boards and the spiking of floors with a nail driver is taken care of by one carman.

Position No. 5, Siding and lining—This gang consists of six carmen, three of whom apply siding and the others lining. All of the siding is furnished cut to length, which is not true of the lining. The floors are also veneered in this position by a car liner. The carmen do not work as a gang, but as individuals.



The organization chart of the B. & M. Concord, N. H., freight car repair shops

Position No. 6, Roof, doors and trim—Twelve men compose this gang, which is divided into three groups of three carmen and one material laborer each. Another gang, consisting of two carmen and a helper, repair and assemble on jigs the doors, ladders, running board extension, etc., for delivery to position No. 6. These parts are sent directly from the stripping position to this gang so that the trim will be ready when the cars reach the trim position, thus expediting the movement of the cars through the shop.

In this position, the metal roofs are also applied, which includes door track filler, end and side facia, and the longitudinal and lateral running boards. The work of the door gang includes applying the door tracks, hanging the doors, and applying the front and back door stops, the door guides and the doorway chafing irons. The trimming gang applies all safety appliances, sheathing, strap bands, etc. The retaining valve pipe is applied in this position. This is the last position in the shop.

Position No. 7, Paint—The cars are hauled by a tractor to the paint shop where they receive a second coat of paint sprayed on and brushed down. The first coat of paint is applied to the parts before they are placed on the car, either by spraying or dipping.

Position No. 8, Stenciling—The cars are moved by tractor from the paint shop to the scales for weighing, after which they are placed in the stencil shop for complete stenciling and testing of the airbrakes. If a new roof has been applied or a repaired roof re-applied this is stenciled on the side plate inside of the car.

Position No. 9, Final inspection—The cars are delivered by tractor from shop No. 3 to the shipping track via the transfer table. Here the cars receive final inspection and touching up before they are released for service.

It requires an average of ten days for a car to pass through the nine repair positions.

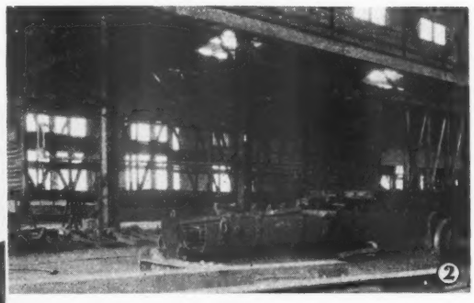
Operation in Shops Nos. 1, 2 and 3

The method of repairing cars in shops Nos. 1, 2 and 3, differs from shop No. 4 in that the men move from one car to another, the cars remaining stationary. Shop No. 1 is used for repairing steel and wood drop-bottom coal cars and the underframes of refrigerator cars. The cars are stripped on the outside and then moved into the shop where they are spotted for repairs. Nine cars are repaired daily with a force of 48 men actually engaged in repair work. These men are divided into gangs of specialists. Certain men do nothing but strip the cars, others repair the trucks and draft gear, and so on. These men move from one car to another doing their particular work. Shop No. 2 is the paint shop.

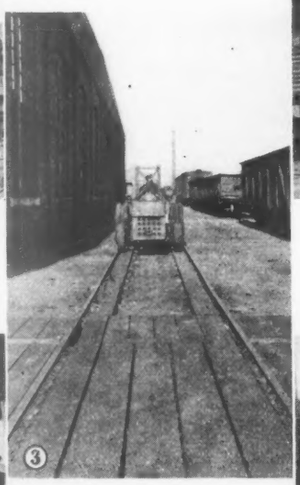
Five tracks in shop No. 3 are used for repairing refrigerator cars and two for caboose cars. A force of 16 men turns out one refrigerator car a day. These men are divided as follows: Four strippers, two men repairing trucks and draft gears, four men in underframe repairs and six men rebuilding the superstructure. The underframes are repaired in shop No. 1 and moved over to shop No. 3, thus concentrating the tools and equipment needed for steel work in one shop and also eliminating a fire hazard from shop No. 3 where all the woodwork and stencilling are done. Four caboose cars a week are repaired by a force of 12 men who work on two tracks in shop No. 3.

After the cars in shops Nos. 1 and 3 are repaired and are ready for paint, they are moved to shop No. 2, where they pass through Positions 7, 8 and 9 in the same manner as the box cars from shop No. 4.

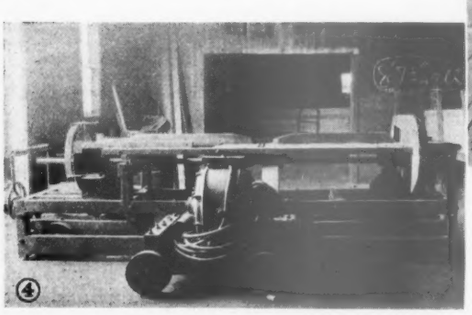
1—Boom type gas-electric truck handling a repaired underframe section



2—A loaded scrap container ready for delivery to the scrap car



3—Planking placed between rails on which tractor operates



4—Double end cut-off saw used for cutting lumber to size as it is unloaded from the car

5—A completed car being hauled over the transfer table for placement on the finishing track

Medium and Light Repairs

The outside tracks on which system cars receive medium repairs are located west of the planing mill. Medium repairs are given to those cars, the condition of which does not justify heavy or general repairs, but which need heavy running repairs. Under normal conditions, 12 workmen complete six cars daily. The medium repair tracks are supervised by the foreman of shop No. 1.

Light repairs to foreign cars are made on three tracks located at the southeastern corner of the shop yard. A daily average of seven cars is repaired by a force of 14 men, who are supervised by the foreman of shop No. 4.

Method of Material Handling and Switching

The system of handling material at the Concord shops has practically eliminated the use of a shop switching crew and the use of hand-drawn shop trucks. Four gasoline tractors, one gas-electric boom truck and 79 trailers are required to transport all the material about the shops and to move the cars from one department to another.

The shops are divided into two zones to each of which is assigned one tractor to move material. The territory north of and including the planing mill is designated as Zone 1, while all of the territory south of the millroom, including the casting shed and dock is designated as Zone 2.

The tractor assigned to cover Zone 1 picks up orders from and delivers material to all points in Zone 1 and also picks up any material for Zone 2, delivering it to a designated transfer depot where the tractor for Zone 2 picks it up for delivery in that zone. The tractor assigned to Zone 2 operates in the same manner. An operator and a helper are assigned to each of these tractors.

A third tractor, with an operator only, is assigned to move cars from position to position and from shop to shop.

The gas-electric truck is used to lift heavy castings, to move the repaired end frames to empty the scrap material containers, and to do all other odd jobs where heavy lifting is required. A spare tractor is kept on hand for emergency use. The four tractors are also used to keep the walks and shop yard clear of snow during the winter.

Each shop supervisor is furnished with a supply of material move-order forms, one of which is illustrated. This form properly made out, must accompany any request for tractor service, whether it be for moving material or spotting cars. Move-order boxes have been strategically located throughout the shops for the use of the foremen. Where loaded trailers are to be moved, the move-order form is made out in triplicate. The original is placed in the move-order box, the duplicate is placed with the shipment and the triplicate is retained by the party making the request. The form is made out in duplicate when empty trailers are requested for loading. The original is placed in the move-order box and the duplicate is retained by the party making the request. No forms are required for the movement of spare empty trailers to the depot.

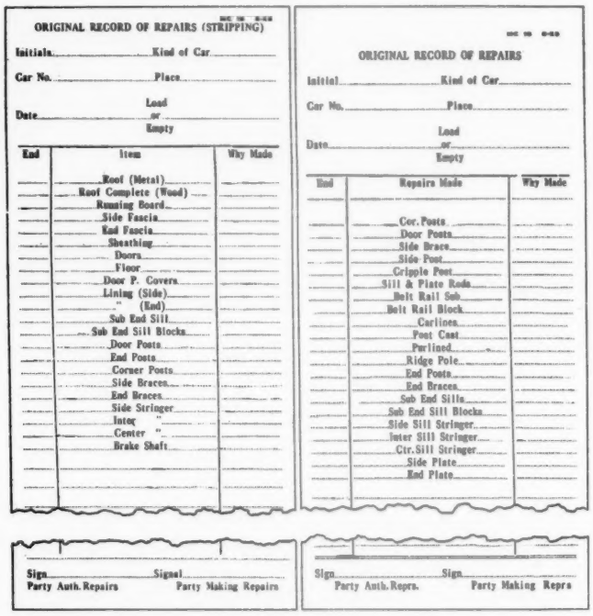
Starting from the depot, which is located at the north end of the planing mill, each operator covers his route in approximately one hour. On each trip, the operator picks up any move-orders, handles all

A general view of Shop No. 4 looking toward the north end of the shop

material covered by the orders and also picks up any spare trailers which he moves to the depot. The operator and his helper unload the material but do not load trailers.

Telephones are located throughout the shops so that the foremen can call the tractor supervisor for emergency movements.

At noontime and at the end of the day the operators hand in their move-order slips to the tractor supervisor. A chart is kept on which is listed the movements of the trailer during the day. The trailer numbers are entered down the left side of the chart and the hours of the day from 7 a. m. to 5 p. m., inclusive across the top. When this chart is filled in, the supervisor has a complete picture of the movements of each trailer for each day from which he can determine the number of movements made. By studying this chart, the supervisor can determine if any trailer is unduly delayed after being moved to a certain department. Thus, if a trailer is set in the planing mill at 10 a. m. and is not moved at 4 p. m., the supervisor investigates to determine the cause of the delay. At the end of each day, all empty trailers are returned to the depot and the location of the remainder can be determined by referring to the chart.



Two more forms used in Shop No. 4

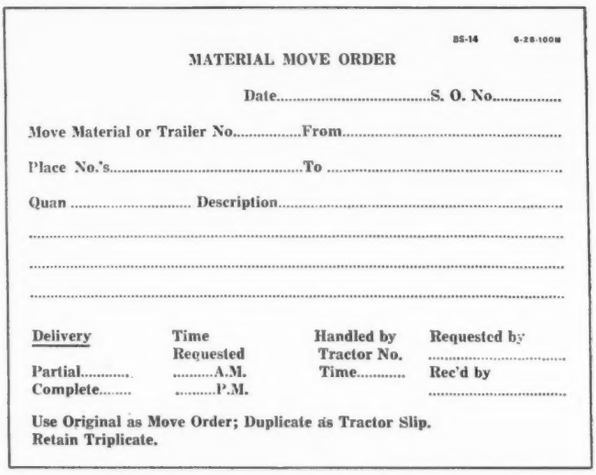
Movement of Cars

The operator of the switching tractor will not move a car unless he is furnished a move-order by a shop supervisor. This tractor moves the cars from position to position in shop No. 4 and from one shop to another. In order to expedite the movement of cars outside of the shop and to reduce wear on the tractors to a minimum, heavy planking has been placed between the rails of all tracks over which the cars are moved. The shop switching crew is used only to spot cars on the outside tracks where light and medium repairs are made and to place the cars on the stripping tracks.

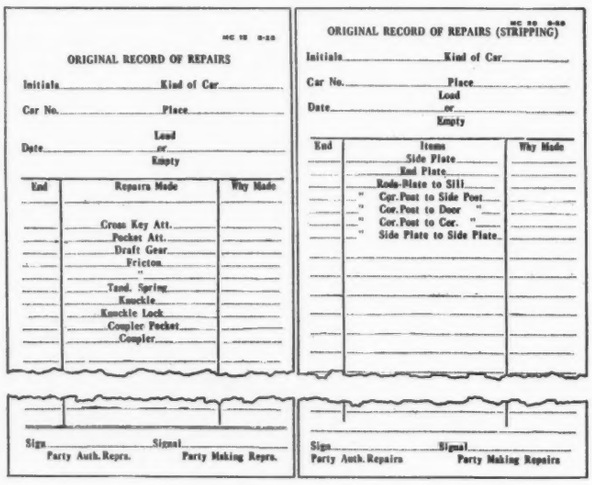
The installation of the tractor-trailer material-handling system has brought about several economies. It has practically eliminated the use of a shop shifting crew, thus reducing to a minimum, the delays caused by waiting to have cars moved. It has also increased the safety of the workmen by not having a locomotive constantly moving about the shop yard. Formerly, material was placed on shop trucks, which were hauled by laborers. The use of shop trucks has been entirely eliminated and the number of material laborers, considerably reduced.

Handling of Scrap Material

At the two stripping positions, depressed tracks have been located on which are placed cars to receive scrap lumber as the cars are torn down. The lumber is either thrown directly into the cars by the workmen or is picked up by laborers and placed into the cars. Scrap containers are placed throughout the shops, which, when filled, are picked up by the gas-electric truck and carried to the scrap cars. Small incinerators are located at the stripping positions in which small pieces of lumber are burned.



A material move order form must be filled out for the movement of material or a car



The form shown at the left when filled in indicates the repairs made to the draft gear and the one at the right is used by the stripping crew

When a metal roof is moved from a car, the sheets are tied up in bundles and taken to a separate build-

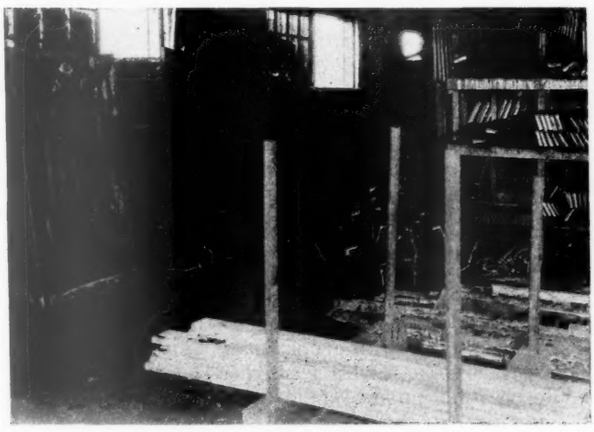
ing where roofs and car door hangers are repaired. The building which is 70 ft. long by 20 ft. wide, is equipped with straightening presses, a paint vat and shelving in which the roof sheets and parts are placed

The stripping tracks outside of Shop No. 4 showing the depressed track for loading material

for drying. The roof sheets are inspected, repaired and dip-painted. The flashing is straightened and painted. New roof sheets and parts are brought to the shop to be dip-painted. The roof sheets and other parts are tied up in bundles and delivered to the cars, ready for application. All of this work is done by one man, who reclaims about 75 per cent of all of the roof parts brought into the shop.

Handling of Lumber

Two long sheds, located in close proximity to the planing mill, are provided for lumber storage. As the

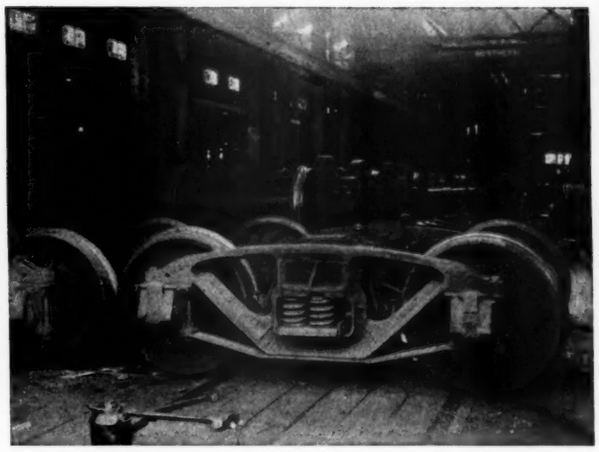


The roof reclaiming department

lumber is unloaded from the cars, it is inspected for defects. After passing the inspector, lumber for siding, sheathing, etc., is cut to size by a portable, double-end cutoff saw operated by two workmen. The cut lumber is loaded directly onto the special lumber trailers, either for delivery to the shop or for storage. This system has reduced considerably the boardfeet of lumber handled in the planing mill and also the amount of lumber required to be cut at the repair tracks.

Conclusion

The important factors in the development of the freight car repair system at the Concord shops are the specialization of tasks, the prompt delivery of material and the prompt movement of cars. The workmen are carefully selected for and assigned to the task for which



The trucks are repaired on a raised track

they are best suited. Laborers, whose duties are to keep on hand the material used at their stations, are assigned to each position. These men become as familiar with the material needed as the carmen.

Decisions of Arbitration Cases

(*The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.*)

Limiting Dimensions of Journal So Near Condemning Limit That It Could Not Be True

On August 18, 1926, Louisville & Nashville car No. 101458 was delivered to the Chicago & Eastern Illinois by the L. & N. on which date the owner issued a defect card to cover one cut journal at location R-2. The C. & E. I. made repairs to the car on authority of the defect card. The L. & N. upon receipt of the repair bill, took exception to the manner in which the C. & E. I. assessed the charge, inasmuch as the adjustment was made on the basis of a scrapped axle removed, notwithstanding the fact that the C. & E. I. billing repair cards showed that the dimensions of both the axles, removed and applied, met all the requirements of good second-hand axles as outlined in A. R. A. Rule 86. A billing repair card and wheel statement furnished the L. & N. by the C. & E. I. in substantiation of the charge, listed no comment or notation concerning the condition of the axle removed other than "Cut journal L-2 scrap." The C. & E. I. maintained that an examination of the damaged axle showed that the journal had been cut to such an extent that it could not be trued up and returned to service within the A. R. A.

limits of a serviceable axle, as shown in the A. R. A. Rules of Interchange, and that the axle was actually scrapped. The C. & E. I. further contended that it should not give the L. & N. credit for a second-hand axle which it damaged in service to the extent that it could not be restored to service within the limits of the rules prescribed by the association.

In rendering its decision, the Arbitration Committee stated "It is the opinion of your committee that a second-hand axle removed with a cut journal on which the length or diameter of the journal or the thickness of the collar is so close to the condemning limits that the journal cannot be trued without exceeding one or more of these limits, is properly credited at scrap value. Therefore, the contention of the Chicago & Eastern Illinois is sustained."—*Case No. 1574—Louisville & Nashville vs. Chicago & Eastern Illinois.*

Passenger Train Refrigerator Car Not Intended for Hump Switching Service

On September 8, 1926, Merchants Despatch passenger-equipped refrigerator car No. 8049, was damaged to the following extent in hump switching by the Belt Railway Company of Chicago:

B —1 metal end sill broken
A & B—2 metal side sills buckled at the bolster
B —2 metal center sills buckled at the bolster
B —1 buffer bent
B —1 passenger type cast-steel truck frame broken
B —1 safety chain eye bolt bent
B —End of car pushed out at the bottom and the end posts broken
B —Side posts and braces from the end of the car to the bolster broken
B —Ice tank broken
A & B—4 brake beams bent
B —Steam train-line end valve missing

The accident report furnished to the Merchants Despatch stated that the accident was caused by insufficient braking power; that the car had tunnel brakes at both ends; that the rider could not get a club in the brake wheel and when he saw that he was losing control of the car, called for a skate. Two skates were used to stop the car without success, resulting in the car colliding with other standing cars, causing the above damage. The Merchants Despatch maintained that as the car was passenger-equipped and had a hand brake, the operation of which required a brakeman to stand on the end sills and between the cars, it was neither built, nor intended, for hump-switching and, therefore, if so handled and damaged, the handling line should be responsible under Rule 32, Paragraph (d). The owner also pointed out that the car had been handled by itself with rider protection and was allowed to strike other cars with such impact as to cause buckling at the bolster of two metal center sills and two metal side sills. This in itself made a combination of defects which, under Rule 44, required a statement of the handling line showing the circumstances under which the damage occurred if it undertakes to establish the responsibility of the owner. The handling line failed to show that there was a defective condition in the car, which contributed in any manner to its failure. The handling line maintained that a passenger-equipped refrigerator car in freight service should contain brake equipment equivalent to that of an ordinary freight car. The lack of sufficient braking power on the car led to the accident which the handling line considered the owner's responsibility.

The Arbitration Committee in its decision stated "In view of the combination of damage, the handling line is responsible as per passenger Rule 8, Section A, Item 4."—*Case No. 1575—Merchants Despatch, Inc., vs. Belt Railway Company of Chicago.*

Joint Evidence Must Be Secured Within 90 Days In Order To Claim Improper Repairs

On December 17, 1926, the St. Louis-San Francisco applied 877 sq. ft. of side and end sheathing to Chicago, Burlington & Quincy car No. 113083, in connection with other repairs chargeable to the owner. On August 26, 1927, the C. B. & Q. informed the repairing line that the sheathing lumber used had dried and shrunk leaving openings from ⅛ in. to ¼ in. between the tongue and groove of each board, thereby rendering the car unfit for ordinary lading which necessitated the renewal of the entire sheathing on both sides and the ends. The owner's statement was supported by a joint evidence secured August 17, 1927. On September 21, 1927, a request for a defect card was declined by the repairing line on the grounds; first, that the repairs had been made in first-class manner and that the lumber met A. R. A. specifications and second, because the car was delivered home, December 24, 1926, seven days after the repairs had been made and as the joint evidence was not secured until August 16, 1927, the 90-day time limit of Rule 12 had been exceeded and, therefore, the request for the defect card was not valid.

In rendering its decision, the Arbitration Committee stated "The Chicago, Burlington & Quincy failed to obtain the necessary joint evidence within the time limit (90 days), after first receipt of car home, as per Rule 12, fifth paragraph. Therefore, the claim of improper repairs is not sustained."—*Case No. 1576—Chicago, Burlington & Quincy vs. St. Louis-San Francisco.*

Ballot on Brakes and Brake Equipment

CIRCULAR No. D. V.-618, recently issued by the A. R. A., Mechanical Division, shows the results of the supplemental letter ballot on the recommendations made by the Committee on Brakes and Brake Equipment, submitted at the annual meeting held in June, 1928, at Atlantic City.

The question of badge plates for identification of brake levers standard to freight equipment cars was passed for submission to letter ballot in addition to those items which were covered under the heading "recommendations" in the report of the Committee. It was the thought of the chairman of that committee that further action was necessary before the subject should be voted upon by letter ballot, and the secretary was requested to hold the subject in abeyance.

In view of the fact that an investigation conducted by the Committee disclosed that of a large number of cars inspected, only about 25 per cent came within the present A. R. A. requirements for braking ratios, the average varying between 17.4 per cent and 271.1 per cent or a difference of 253.7 per cent, from the standpoint of damage to wheels and brake shoes the question was considered of such importance as to warrant its submission to letter ballot at this time to the members of the association.

This recommendation of the Committee is contained in the report of the Committee to the 1928 annual meeting, Circular D. V. 571, and reprinted in letter ballot Circular D. V. 613.

The vote on the recommendation from the Committee on Brakes and Brake Equipment was in one proposition and was as follows:

1. On the proposition that a metallic plate be made a standard part of every car and fastened to the underframe, as recommended by the Committee on Brakes and Brake Equipment, to contain the proper dimensions of levers for both body and truck brake gear, and that a rule be provided governing the replacing of levers, etc.

The foregoing proposition has been approved by a substantial majority by the members of the American Railway Association, thus amending the Standard and Recommended Practice of the Division to be effective March 1, 1929.

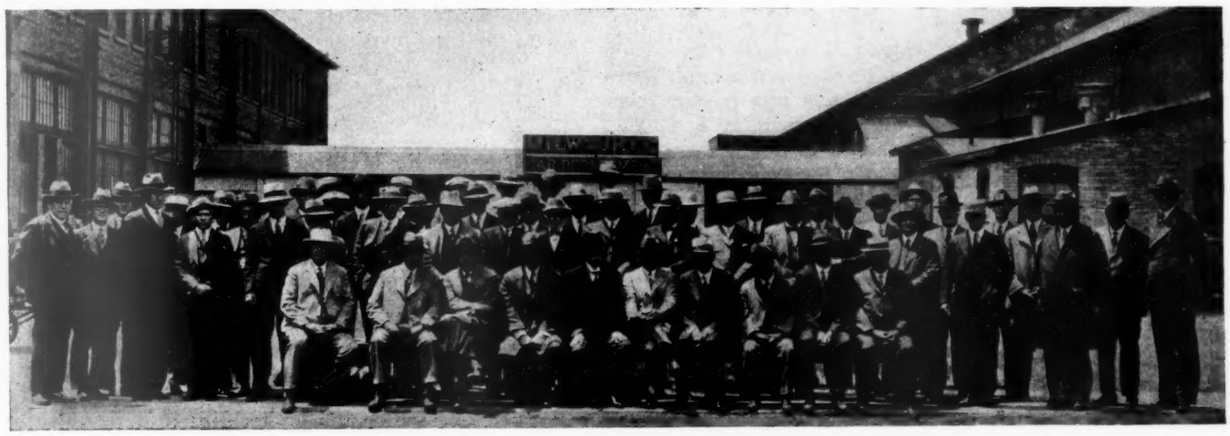
How To Reduce Bad Order Cars*

Seven important suggestions, developed through experience on the Milwaukee, are advanced

By K. F. Nystrom

Superintendent Car Department, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.

THE keeping of bad orders at a minimum requires a comprehensive and carefully laid plan of action; it requires a thorough knowledge of car construction as well as familiarity with the physical condition of the equipment. The plan of necessity must include proper attention to the following seven factors: Car department organization; proper design for new cars to meet the present day service requirements; a well-balanced retirement program with a knowledge of the depreciation and retirement accounts; a systematic method of repairing cars; keeping air brakes, rods and levers, and draft gears in good condition; co-operation with the stores department to insure adequate supply of material at all times; constant policing of cars damaged in train yards by rough handling.



Car officers responsible for Milwaukee equipment condition—1928 annual staff meeting

Car Department Organization

Admittedly there is a difference of opinion and practice as to the most effective car department organization. Where it can be satisfactorily arranged, many believe it preferable to have a self-contained car department organization with the ranking supervisor reporting directly to the chief operating officer.

The organization within itself is of most vital importance and should be divided into sections or districts with an officer in charge of each section reporting to the head of the car department, and these sections to be re-districted with a general foreman in charge of each reporting to the district supervisor. There was a time when foremen had as many as 100 or more men assigned to them. However, in these days of high-priced labor it has been found profitable to increase the supervision. Generally speaking, it is not considered good practice to have more than 25 men directly assigned to each supervisor.

Well Balanced Retirement Program

The matter of proper car construction is one of utmost importance but takes in such a wide scope, involving engineering studies, service characteristics, and other experience factors, that it is really a subject in itself. We cannot expect to produce a satisfactory operation and confine the maintenance-of-equipment expense to a min-

*A paper presented at the December, 1928, meeting of the Car Foremen's Association of Chicago.

imum without giving this important subject most careful study when new equipment is purchased.

Many car department supervisors do not have a clear conception of what is meant by the depreciation and retirement charges and what effect it has on the final maintenance of equipment accounts. It means that when stockholders furnish a new car they ask that the car department maintenance-of-equipment accounts pay for it without interest in monthly installments. These payments for freight cars are known as I. C. C. depreciation Account 315. If a car is destroyed before all payments are made or if the payments are too small

CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC R.R. CO.

Bad Order Cars on Hand and Repaired

Location System Date Tues. Nov. 20, 1928 6:00 P.M.

KIND OF CAR			ON HAND							REPAIRED					
			A Lt.	B Med.	C Hvy.	D Very Hvy.	E Held F Auth.	for Diem. G Not Auth.	J Tot.	K Rum.	L Lt.	M Med.	N Hvy.	O Very Hvy.	S Tot.
Auto	System	1	41	26	10	29			106	34	30	2	2	3	71
	Foreign	2	6		2	1			9	31	23				54
Ballast	System	3	6	8		22	1	3	38	2	11			1	14
	Foreign	4													
Box	System	5	124	78	69	311	19	35	636	586	356	13	5	16	1076
	Foreign	6	11	2		6		1	20	433	72				505
Coal	System	7	123	84	132	96	21	116	568	345	149	9	4		507
	Foreign	8	13						13	236	62				300
Flat	System	9	65	19	16	14	37	42	193	211	112				323
	Foreign	10	3	1					4	38	6				44
Ore	System	11	26	11	3	16		15	73		5	3			8
	Foreign	12													
Ref'g.	System	13						1	1	2					2
	Foreign	14	10						10	163	42				205
Stock Single	System	15	49	3		3	14	24	87	60	32				92
	Foreign	16		1	1	2			4	19	8				27
Stock Double	System	17					3	1	4	3	5				8
	Foreign	18								2					2
Tank	System	19								1					1
	Foreign	20	11		1	1			13	107	19				126
Caboose	System	21	4			36	1	2	42	39	20	2		1	62
	Foreign	22								2	1				3
Work	System	23	55	19	9	3	26	86	198	33	22	2		2	59
	Foreign	24													
Total	System	25	487	243	289	550	122	322	1943	1406	742	31	11	28	2218
	Foreign	26	54	4	4	10	-	1	73	1033	235	-	-	-	1268
GRAND TOTAL		27	541	247	293	560	122	323	5016	2439	976	31	11	28	3479
Grand Total Last Year		28	585	496	311	2584	-	-	3974	2915	1159	46	12	28	4160

	Working O	Abs. W	Ins. T
No. of men	2719	168	8
Last Yr.	2859	141	0
	140 Decr.	24 Incr.	2 Incr.

Revenue cars on line - 76208

% of Rev. Bad Order Cars to Rev. cars on line this year - 2.8

% of Rev. Bad Order Cars to Rev. cars on line last year - 4.7

Office of Supt. Car Department
November 22, 1928

Signed .....
Supt. Car Department

Exhibit I

so that the car is worn out before all payments are completed, the remaining debt must be paid in one lump sum when the car is dismantled and this last payment is called a retirement charge and is known as I. C. C. Account 316, freight train car retirements. This retirement account, being one of the primary maintenance-of-equipment accounts, has a tendency to throw the total maintenance of equipment charges considerably out of balance and beyond advance estimates made, if a large retirement charge must be absorbed covering a considerable number of cars. It is possible that the cars may have reached their retirement stage earlier than anticipated because of improper construction or faulty design, deferred maintenance, advance obsolescence or too low a rate of depreciation, but in any event if the ranking car-department supervisor is familiar with the so-called book value of the cars he will be in a position to advocate a policy to continue the cars for a certain number of years service, consistent with the construction and physical condition of the equipment.

At first consideration it may not seem practical to set up an intelligent retirement program because of the difficulty in anticipating what is going to happen to the equipment in the next year or two; however, after further study, we will find that with few exceptions cars built, say, 20 years ago, are of practically the same construction throughout the country and it is rather easy to determine the general condition of the equipment and obtain a comprehensive idea as to how the equipment stands up in service and what measure should be taken in the way of retirements or to condition the cars for the remaining period of their natural life. If a certain class of car continually moves from one repair track to another, indicating poor design or weak construction which cannot be remedied, serious consideration should be given to retiring the entire series gradually.

A practical and economical way to get rid of the troublesome cars is to set up a maximum amount of repairs which will be allowed per car. When this limit is set it should be made on a man-hour basis rather than a money limit, as to use a fixed amount of money as a limit for repairs to a car to be retired, is not satisfactory. For instance, it may be necessary to change one or more pair of wheels under a particular car and the cost in this case would exceed the amount which would normally be considered the limit for repairs for this equipment. A limit of a maximum number of man-hours, 20 or more per car, has proved to be simple and practical, as an experienced supervisor can always estimate, with reasonable accuracy, how many hours it will take to repair a certain car, but if money is used as a basis it is necessary, in addition to the labor, to also consider material and overhead which considerably complicates the issue. If a limit is set for a given series of cars it will not take long to find out what will happen, and if necessary, adjustments can be made so that the desired number of cars are set out for dismantling. This method forms a workable basis for a dismantling program and permits all cars to remain in service until worn out.

In certain series of cars the trucks may be in good condition and in those instances instructions can provide for maintaining the trucks provided the body of the car can be repaired within certain man-hour limits. After the program has been in force for a while it will be possible to estimate rather closely the number of cars which should be taken down during the following twelve months or even for the next two or three years. As far as the railroad with which the writer is associated is concerned, approximately 3½ per cent retirement per year to the total ownership has been tentatively worked up as a natural development of the procedure outlined, subject to adjustment to produce the proper turnover of new equipment.

Systematic Method of Repairing Cars

Having laid the proper foundation for retirement of worn-out equipment it then becomes the duty of the car department supervisors to keep the remainder of the equipment in a good state of repairs at a minimum cost. Here it is that the car-department efficiency can be measured, as all repairs to freight-train cars are charged to one account, namely, I. C. C. Account 314, freight train car repairs, and comparison with other railroads can readily be made.

Formerly, it was customary to bring in defective cars, regardless of class, and repair them in the shop as they were marked out in the train yard. Today a systematic handling of one class of cars only is generally scheduled for a given shop. It appears logical that if a certain number of cars of one class are built or turned out from a car builder's shop at about the same time or within a few months, these cars, after a certain length of service, require about the same attention in the form of general repairs. Experience in actual service has proved this to be a fact and therefore a certain series of cars should undergo general repairs after a given length of time.

Can it be determined how often a car should receive general repairs? What is the proper repair cycle? It

can hardly be expected that we can come to a general agreement on this point as some railroads follow a policy of shopping equipment more frequently than others. However, it will be admitted that most railroads have for many years repaired passenger cars on a fixed program; that is, after a certain number of months in service, the cars are taken into the shop for general repairs. This practice has proved to be both practical and necessary. Why not introduce a fixed shopping program also for freight cars.

After careful study and observation, the Milwaukee has adopted a four-year shopping cycle for its freight cars. We have found that on cars having wooden superstructure, the rods and bolts become loosened due to shrinkage of lumber, also mechanical wear caused by the racking of the car. By bringing the car to the shop for specific attention, such as the tightening of all rods and bolts, renewing parts of siding and renailing where necessary, and renewing of flooring as required, the life of the superstructure is lengthened and maintenance cost reduced. On cars having outside steel framed superstructure the same attention as to tightening of bolts is essential; metal roofs of these cars, particularly, must receive frequent attention in the way of drawing down bolts in order to keep the roofs water-tight. We find that cars generally require painting about every four years, this being especially true of the steel framed cars. In order to lengthen the life and reduce maintenance cost we have found it a good policy to wire-brush exposed steel parts and paint them. Likewise, the wooden parts are preserved by frequent painting. When the cars are on the repair track in the four-year cycle, special attention is given to air brakes, trucks, draft gears, doors and roofs, etc., and renewals of any parts that may become worn or defective.

On the basis of an ownership of 72,000 cars, 18,000 cars would be repaired each year on this four-year cycle, or 60 cars per day based on 300 working days per year. The repairs to these 60 cars each day are distributed among 11 different points as shown in Exhibit No. 2. The assignment of repairs to a certain class of cars is given careful consideration so that the repair point is in a locality where there is a natural flow of this class of equipment. In this manner it is not necessary to back-haul any great distance any class of cars for general or schedule repairs.

It will be noted from the table that in almost all instances one class of car is repaired at two, and in some cases three different points. This is done to create friendly competition. All work is performed on shop orders so that at the end of each month the auditing department issues a statement showing the average cost of repairs per car. The auditing department handles the accounting and no cost statement is made up by the car-department forces, therefore the cost as obtained is considered by all repair points as accurate, resulting in an effort, at each point, to excel the other points handling the same class of cars and there exists a friendly feeling of competition between the various shops. In order to enforce uniform practices, inspectors visit the shops to see that the repairs are uniform at all points and that the charging of material is handled uniformly and in accordance with the accounting rules.

With the low percentage of bad orders prevailing on the Milwaukee today it is obvious that there are not as many bad-order cars of each class available as are required to keep the shops busy. It is therefore necessary to mark out cars which might otherwise be allowed to remain in service, and let them go through the shop for general repairs. This is considered very desirable and in line with the old saying "A Stitch in Time Saves Nine." By following the four-year repair cycle it also results in making more cars available for any class of loading and overcomes the unsatisfactory condition of having too many rough freight cars on the railroad, which occurs when cars are not shopped frequently.

It is also obvious that cars built, for example, in 1924, would be thought to be in serviceable condition today, yet, with the four-year repair program in effect, this equipment is now taken into the shop for general repairs. It is surprising to find how many small items need attention and we are firmly convinced that considerable money is saved by this new shopping program. In some instances the attention required, particularly on cars not over five years old, may only constitute medium repairs on a man-hour basis. Nevertheless, we take the cars in and perform all necessary work so as to condition the car for another four years' service.

Keeping Air Brakes, Draft Gears, etc., in Good Condition

The most effective means of preventing cars repeatedly coming on the repair tracks is to put the air brake and draft gears in as near 100 percent condition as possible when the car is undergoing general repairs. So far as the air brake is concerned, this is well taken care of by following the present A. R. A. requirements. This attention given to the air brakes results in better service rendered and the cars are given the best protection.

The use of proper rods and levers is most essential if we expect the air brake to function properly. In the past, sufficient attention has not been given to maintenance of proper length of brake rods and proper pro-

Freight Cars - C.M. St.P. & P. and C.T.H. & S.E. - Built Prior to 1925
Number To Receive Repairs Daily & Number Repaired Monthly

Class of Car	Sch. No.	Series Numbers	No. Cars Owned 4-1-28	Number To Be Repaired Daily: Milwaukee	Galewood	Dubuque	Minneapolis	Green Bay	Muskegon	Tacoma	Miles City	Deer Lodge	St. Maries	Terre Haute	Total
Auto	10	590000-590249	245												
Auto	11	591000-592024	1021		3										
Auto	16	206501-207470	895												
Box	3	72826-81476	650												
Box	4 & 4A	81482-83480 / 87484-93480 / 500000-506204	9782	2						5					7
Box	5	83482-87482													
Box & Auto	5	200000-206500	7838	4											4
Box	7	700000-703999	3977	2			4					2			8
Box	8	705000-710499	5489		4		2	2							8
Box	9	506206-508204	1949	1			1								2
Coal	32	300000-302499	2396		2										2
Coal	35	303000-310824	7618					½			½			½	9
Coal	A	2000-6499 / 9051-9150	651												
Coal	B	6500-6999	442											1	1
	C	11000-14499	1448												
Hopper	D	7000-7399	907											1	1
	33	67801-67839													
Ballast	40	70971-73969	948		1		½				½				1½
Ore	34	25493-25891													
	A36	50001-53799	1713												
Flat SGM Cap. Wood	27	45701-45999 / 58001-58999	1155							1			½		1½
Flat Steel C.S.	3-F	46001-46018 / 65001-54499 / 64001-64999	562					½	½	½					1½
Flat Steel	28	60001-62003 / 62101-63639 / 30000-30499	1726					½		½				½	1½
Cabooses	42	01-01499 / 01500-01524 / S.E.1-48	988			1				½					1½
Misc.	M			2	1	1	1	½		½					6
Total				12	11	2	8½	4½	½	7½	1½	2	½	10½	60

Exhibit II

portion of levers. To have a good air brake it is equally important to have proper brake power and angularity of levers as it is to have the air brake function properly. Wrong rods or levers are frequently the cause of slid-flat wheels, bad braking conditions resulting in undue slack action in trains, which contributes to breakage of knuckles and otherwise damage to the equipment; therefore, it is essential that this feature receive careful attention. The practice of stencilling the center

sills or cross beams of cars to show the dimensions of rods and levers, as recommended by the A. R. A., should be followed, as we find it of assistance to light-repair men and foreign lines, particularly when missing rods, etc., must be replaced. The above practice has been in vogue for several years on the Milwaukee, and we have found it of great benefit.

The draft gears are of equal importance and should be given the same attention. It is hoped that in the not distant future the A. R. A. will see fit to introduce rules providing for periodical attention to draft gears similar to that covering the air brake equipment. The Milwaukee inspects draft gears in accordance with instructions quoted below in part:

> Regular draft-gear inspection is not expected to be done at points having a force of less than five men, including supervisor.
>
> As all system cars appear on the repair tracks for repairs, the draft gear must be inspected. Where gears show that excessive slack exists or that they have broken parts, they should be dropped and necessary repairs made to the entire draft arrangement.
>
> On all system cars held for heavy, very heavy, or schedule repairs, draft gears are to be dropped, thoroughly inspected and necessary repairs made to the entire draft arrangement. It will not be necessary to drop draft gears held for light or medium repairs unless the draft gear is defective.
>
> Whenever the draft gear has been removed or inspected, the cars shall be stencilled in accordance with drawing E-1889, in one-inch white letters.
>
> Whenever gears have been inspected, they will be reported on the monthly physical change report. If the draft gear was inspected within nine months, it will not be necessary to change the stencil, or report inspection, unless draft gear is defective, or the car receives heavy, very heavy, or schedule repairs.

The above instructions have been in practical use for the past 12 months; the number of cars inspected is increasing monthly. At the present time well over 3000 cars are inspected each month and within the near future we expect to have the number increased so that every car will have a draft-gear inspection every 9 to 12 months, similar to the present requirements on air brake inspection.

The inspection of draft gears reveals that, so far as the Milwaukee is concerned, approximately 18 per cent of the total number of gears inspected are defective.

Co-operation with Stores Department

Without proper co-operation with the stores department, the best method of repairing cars cannot be carried out successfully or economically, resulting in an under supply or an overstock of material, and in many instances wrong and obsolete material being ordered. It is well to remember that any freight car material becoming obsolete in the storekeeper's stock is assessed against the freight car maintenance account just as though it had been used. The storekeeper has no other means of clearing his stock with the purchase cost of such obsolete material, and it must be charged to the repair account for which it was intended, less the amount received for the scrap. By keeping the stores department fully posted as to change in design, standards, etc., such losses can be reduced to a minimum.

When embarking upon a repair program involving material consumption of a larger volume than normally used, or when deciding upon an addition and betterment program necessitating purchase or manufacture of special material or parts, most satisfactory results have been obtained by anticipating our requirements between 60 and 90 days in advance, permitting the stores department to have the material on the ground in sufficient quantities to allow an uninterrupted schedule of output. We make no attempt to start on a special program of this nature until the material is on the ground and we are assured of a constant flow of material to meet our requirements.

Constant Policing of Damaged Cars

In going through the train yards, particularly in the evening, we have all heard the constant bombarding caused by rough handling of cars, reminding us of a battlefield, and except for the comment "That was a good one," or "Hit it again," or some similar remark, we pay little attention to the damage that is being done. Rough handling is more prevalent during the heavy business periods than at other times because of the anxiety to make up trains as quickly as possible and to clear the yards for oncoming movements. We should keep in mind that every time a car is damaged by rough handling it throws an extra burden of expense on the car department and is charged to our maintenance accounts, and when considered for a period of a year we could overhaul many hundreds of cars with money spent in repairing damaged equipment caused by carelessness of switching crews. The remedy, of course, lies with the operating department, but unless the car department supervisors make it a point to take note of and report all cases of cars damaged to the superintendent, we can hardly expect an improvement. We find the superintendents quite willing and anxious to co-operate but without the required information supplied by the car department to permit taking disciplinary action with the train crews responsible, we can hardly expect to obtain any results.

More damage to equipment is done in train yards than generally recognized. The bad order cars can be considerably reduced if there exists a proper co-operation between the operating department and the local car department, and all damage done is promptly reported and preventive measures taken. To illustrate what can be done along these lines, in one terminal 200 cars were damaged in one month. By going after the situation vigorously, the number of damaged cars was reduced to 98. Even this number of cars is too many, but it certainly indicates a move in the right direction and shows what can be done.

General Results

If a program as outlined above is carried out, what results can be expected? It is difficult to say definitely but experience, as in all cases, is the most accurate guide. The Milwaukee bad order figures as herewith re-produced, covering the bad order cars on hand for a recent day picked at random, show that we have 2,016 cars held in bad order, 541 held for light repairs at the close of the day, 1,030 held for medium or heavy repairs and 445 held for dismantling, the total representing 2.3 per cent bad-order cars to total cars on line. In order to keep the repair points giving cars general repairs reasonably supplied with cars it requires between 800 and 900 cars held out of service for general repairs.

The present bad-order situation on all Class I railroads throughout the country as published by the *Railway Age* for September, 1928, is 6.5 per cent. If each railroad would get at the repairs to freight cars in a systematic way, I believe it is entirely possible to reduce the bad orders in the country to 2.5 per cent and possibly even lower. This would mean a reduction of 4 per cent of bad order cars, and assuming that there are 2,300,000 freight cars in the country, it would release

about 90,000 freight cars for service, or the ownership could be reduced by that amount. If the country could get along with 90,000 less freight cars per year, figuring same at an average cost of $2,000 per car, and that 5 per cent has to be paid as interest on the investment, $9,000,000 would be saved each year, in addition to the savings in maintenance because of the lesser number of units.

The average car mileage for the month of September on Class I Railroads amounted to 30 car miles per day. A reduction in ownership of 90,000 cars, made possible by an equivalent number of additional cars made available by a 4 per cent reduction in bad orders, would automatically increase the car miles per day, as well as reduce the per diem charges, an ambition which every operating department officer is trying to realize.

A reduction in the number of bad-order cars, means that the average general condition of the equipment is improved, thus reducing the necessity of marking out cars from made-up trains, which in turn speeds up the operation in terminals and reduces switching expense.

To keep the cars in good repair and a minimum number out of service spells efficiency for the car department and money saved for the individual railroad.

Painting and Handling Sash

Racks on skids, moved on hand or power lift trucks, save handling

OF the numerous methods of saving time and labor which are to be found in use at the Milwaukee passenger-car shops, one of the most effective has to do with the painting and handling of window sash. The sash are loaded on platform skids as they are removed from the car. The skids are then moved by lift trucks to the elevator, by means of which they are taken to the second floor in the car shop, where sash repairs and painting are carried on.

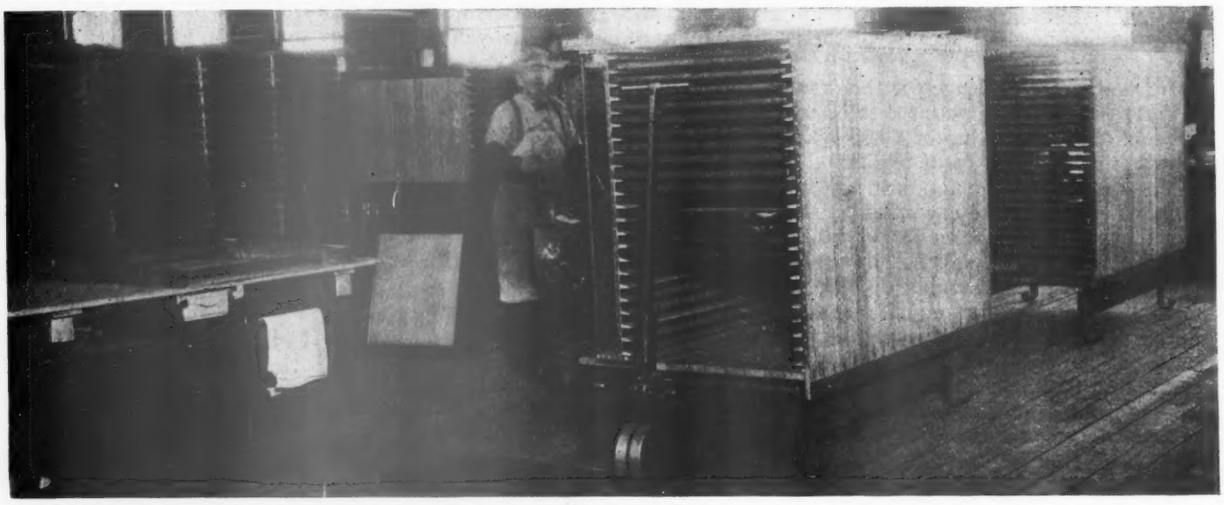
The first operation in the sash department consists of washing the sash which are then sent to the cabinet maker for repairs to frames or glass, then back to the sash department where they are put in special sash-rack skids in which they are moved to the finisher for painting.

These skids consist essentially of sash racks, adjustable to different sash sizes, mounted on metal frames which support them at a sufficient height above the floor to permit running either a hand- or power-lift truck underneath. They can then be raised enough to clear the floor and be moved to any desired point in the shop. These rack skids can be placed for the convenience of the painter, cabinet maker or whoever may be working on them, saving many steps and several rehandlings of the sash. Two rack skids hold a full set

One of the booths used in spray painting sash and other car parts

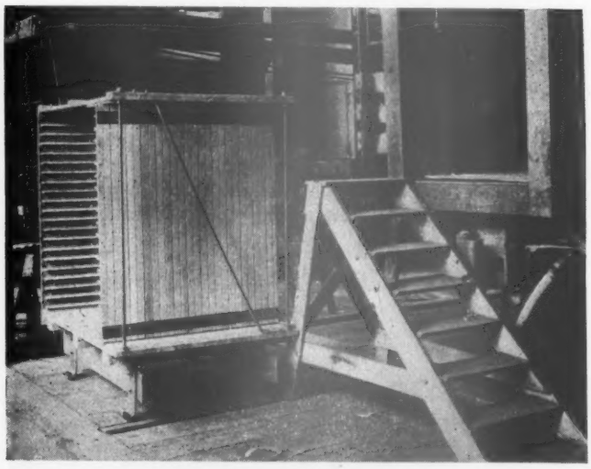
View in the section of the shop devoted to sash washing

of inside and outside window sash, and 36 skids in all are provided. All sash are left in the racks until the painting is completed, when they are taken to the car and given to the trimmer for application.



Sash rack skids, adjustable to different sash sizes, are readily moved by hand or power lift trucks

In spray-painting the sash, special booths are used, one of which is shown in an illustration, arranged with a hood and exhaust fan for ventilation to meet the requirements of the law. Both color and varnish are sprayed, as is also vitrolite when necessary. The sash



This view of a sash rack skid just unloaded shows the construction clearly

are placed on a revolving stand in the booth, and sheet-metal guards the exact size of the glass are provided to protect the glass while spraying the frames.

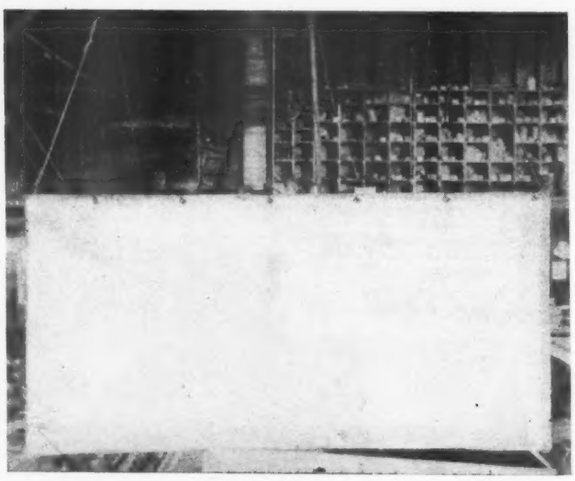
For large sash, the heavier metal guards are suspended by means of a small pulley and cords, which are attached to counterweights so that the guards can be applied to and removed from the sash with little effort and loss of time on the part of the operator. Spray painting on all small trim saves practically 50 per cent of the labor formerly required. On sash, the saving is not quite so large.

Basket racks, sash fittings, coat hooks, grills, etc., formerly lacquered by the dipping process, are now sprayed in special booths. They are removed from the cars and sent to a tank where they are dipped in an acid solution to cut the dirt. They are then rinsed, scratch brushed, buffed, and sprayed with aluminum bronze lacquer, oxidize lacquer, or other finish lacquers, one or two coats being applied, as necessary. A substantial labor saving over former methods results.

A Convenient Welding Booth

By Joseph C. Coyle

THERE is never too much room in the steel car shop and the ordinary welding booth is always more or less in the way when not in use. It is difficult to place heavy material in the booth, unless it is of the folding type, and then it is troublesome to remove and put back in place.



A canvas welding booth which can be lifted up out of the way

The light canvas frame, illustrated, removes all of these disadvantages as it can be quickly hoisted out of the way. It may be of any size desired and is made by stretching canvas over a light frame-work of ¼-in. pipe. Wires are attached to the four corners which lead to a pulley overhead. The weight of the booth is counterbalanced with a heavy piece of metal, so that it may be easily raised above ones head with one hand.

Car Orders Placed During 1928

Nearly 45 per cent of the freight cars ordered are box and automobile—Orders for express refrigerator cars total 600

ACCORDING to statistics compiled by the *Railway Age,* a total of 51,200 freight cars was ordered for service in the United States and 8,901 for service in Canada. Orders for 1,930 passenger cars were placed during the year for service in the United States and 334 for service in Canada. Referring to Tables I and II, it will be noted that Canadian orders for freight and passenger equipment last year exceeded the total ordered any previous year, as far back as the years 1920 and 1919, respectively. Export orders for freight cars were comparatively heavy last year, but export orders for passenger cars were light.

A 50-ton steel-sheathed box car equipped with the Duryea underframe in which the car body is free to move longitudinally on the center sills against a cushion-spring device

Orders for Box and Automobile Cars Predominate

Table III shows the types of freight cars ordered in 1928 for service in the United States and Canada. A total of 16,662 box cars, 27.7 per cent of the total, was ordered during the year. Orders for automobile cars totaled 10,165, or 16.9 per cent of the total number ordered. From the standpoint of total orders for box cars, last year was no exception to previous years, but this is the first time that the total number of automobile cars ordered has stood second in the list of types of freight cars ordered during any one year. During 1927 a total of 74,139 freight cars was ordered, of which 21,296, or 28.7 per cent, were box cars, 17,904, or 24.2 per cent, were gondola cars and 5,800, or 7.8 per cent, were automobile cars. In 1926, out of a total of 68,524 freight cars ordered for service in the United States and Canada, 16,055, or 23.6 per cent, were box cars, 13,033, or 19 per cent, were hopper cars and 10,489, or 15.5 per cent, were refrigerator cars. Only 5,674, or 8.2 per cent, were automobile cars. In 1925, a total of 93,475 freight cars was ordered, of which 31,037, or 33.2 per cent, were box cars, 23,317, or 25 per cent, were gondola cars and only 10,016, or 10.7 per cent, were automobile cars. Practically the same percentages of box, automobile and open-top cars were or-

dered in 1924, as were ordered during 1925.

It is also interesting to note the total orders for refrigerator cars during the five-year period, 1924 to 1928, inclusive. Of the 147,335 freight cars ordered in 1924, 14,447, or 9.8 per cent, were refrigerator cars. A total of 7,358 refrigerator cars, or 7.8 per cent, was ordered in 1925. The year 1926 was the best year of any of the five years from the standpoint of refrigerator cars ordered, while in 1927 the number had dropped back to 9.6 per cent of the total.

Table I—Orders for Freight Cars Since 1918

Year	Domestic	Canadian	Export	Total
1918	114,113	9,657	53,547	177,317
1919	22,062	3,837	3,994	29,893
1920	84,207	12,406	9,056	105,669
1921	23,346	30	4,982	28,358
1922	180,154	746	1,072	181,972
1923	94,471	8,685	396	103,552
1924	143,728	1,867	4,017	149,612
1925	92,816	642	2,138	95,596
1926	67,029	1,495	1,971	70,495
1927	72,006	2,133	646	74,785
1928	51,200	8,901	2,530	62,631

The preceding analysis of the types of freight cars ordered during the past five years is of interest, due to the fact that that period has seen the larger part of the development in motor truck and, to a considerable extent, waterway competition. It also shows, the importance of the automobile industry to the railroads as a source of lading and also the demands that are being made on the railroads for the handling of perishable products, such as fruits and vegetables.

Cars Built

Referring to Table IV, only 46,060 freight cars were built for service in the United States last year. This total, with one exception, is the lowest since 1913. The year 1921 saw only 40,292 freight cars built, which is 5,768 cars less than the number built in 1928. On the other hand, the number of freight cars built for service in Canada last year totaled 5,158, which is the largest number built since 1921.

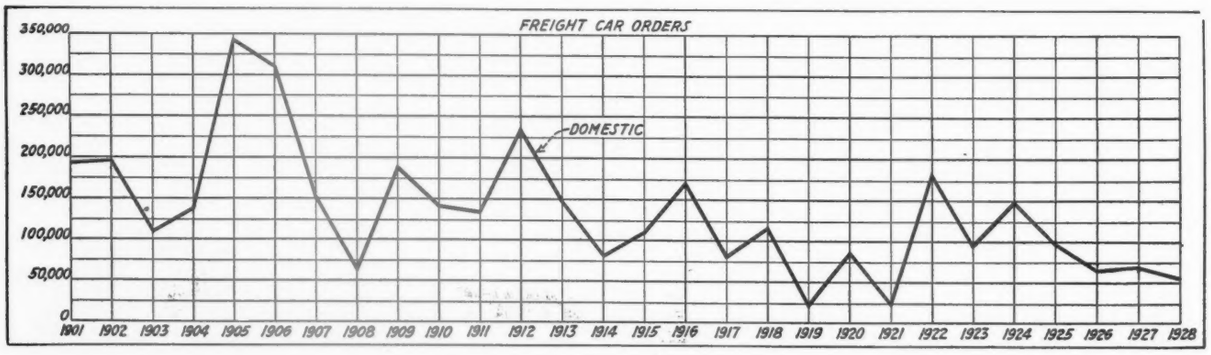
Table II—Orders for Passenger Cars Since 1918

Year	Domestic	Canadian	Export	Total
1918	9	22	26	57
1919	292	347	143	782
1920	1,781	275	38	2,094
1921	246	91	155	492
1922	2,382	87	19	2,488
1923	2,214	263	6	2,483
1924	2,554	100	25	2,679
1925	2,191	50	76	2,317
1926	1,868	236	58	2,162
1927	1,612	143	48	1,803
1928	1,930	334	29	2,293

Two developments in freight-car construction that are marked departures from long-established practice are an underframe design which has been applied to more than 2,000 cars during last year, and a tight-lock coupler*, which provides a rigid drawbar connection from the point of attachment on the underframe of one car to the point of attachment on the underframe of the adjoining car, without sacrificing interchangeability with the present standard couplers. Last year also marked a further tendency in the use of cast steel in the construction of railroad rolling stock. The Duluth, Missabe & Northern placed an order for ore cars with unit steel underframe castings. Another example of the use of cast steel in freight car construction is the hopper car which was exhibited by the Wine Railway Appliance Company at Atlantic City last June, in which a number of structural parts, commonly built up of plates and sections, were replaced with steel castings. Aside from the other known advantages of the use of cast steel in car construction in a car handling material from which there are corrosive drippings, the unit structures of cast steel are less effected by corrosion. The Car Construction Committee of the Mechanical Division, A.R.A., is making steady progress in the de-

Table III—Types of Freight Cars Ordered in 1928 for Use in the United States and Canada

Type	Number	Per cent
F.—Flat and logging	4,732	7.9
G.—Gondola	5,605	9.3
H.—Hopper	7,317	12.2
R.—Refrigerator	6,752	11.3
S.—Stock and poultry	1,952	3.2
T.—Tank	1,814	3.0
X.—Box	16,662	27.7
Automobile	10,165	16.9
Ballast, dump and ore	2,835	4.7
Not classified	1,868	3.1
N.—Caboose	399	.7
Total	60,101	100.0



Freight car orders, 1901 to 1928

Table IV—Freight Cars Built Each Year Since 1913

	United States			Canadian			Grand total
	Domestic	Foreign	Total	Domestic	Foreign	Total	
1913	176,049	9,618	185,667	22,017	....	22,017	207,684
1914	97,626	462	98,088	6,453	....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	....	....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708
1919	94,981	61,783	156,764	6,391	30	6,421	163,185
1920	60,955	14,480	75,435	....	....	....	....
1921	40,292	6,412	46,704	8,404	745	9,149	55,853
1922	66,289	1,126	67,415	458	100	558	67,973
1923	175,748	2,418	178,166	....	....	....	....
1924	113,761	1,141	114,902	1,721	....	1,721	116,623
1925	105,935	3,010	108,945	....	....	....	....
1926	88,862	2,771	91,633	1,645	....	1,645	93,278
1927	63,390	1,087	64,477	2,851	....	2,851	67,328
1928	46,060	938	46,998	5,158	....	5,158	52,156

* A description of this coupler appeared in the June 20, 1928, issue of the *Railway Age*, Daily Edition, page 1420D60.

velopment of designs which are to become the standards of the association. The general design of a steel-frame, double wood-sheathed automobile car for unrestricted interchange, which will have inside dimensions of 40 ft. 6 in. by 8 ft. 7¾ in. and 9 ft. 1⅝ in., and a similar car for restricted interchange, which will be 9 ft. 2 in. wide by 10 ft. high inside and will be designed in lengths of 40 ft. 6 in. and 50 ft. 6 in., was adopted in a recent letter ballot. The designs of both types will cover the use of both 10-ft. 6-in. and 12-ft. side door openings, and will also permit the use of end doors where these are considered desirable. The proposed general designs of the 50- and 70-ton hopper cars were also accepted by the recent letter ballot.

Table V—Passenger Cars Built Each Year Since 1913

Year	United States Domestic	United States Foreign	United States Total	Canadian Domestic	Canadian Foreign	Canadian Total	Grand total
1913.....	2,559	220	2,779	517	....	517	3,296
1914.....	3,310	56	3,366	325	....	325	3,691
1915.....	1,852	14	1,866	83	....	83	1,949
1916.....	1,732	70	1,802	37	....	37	1,839
1917.....	1,924	31	1,955	45	....	45	2,000
1918.....	1,480	92	1,572	1	....	1	1,503
1919.....	306	85	391	160	....	160	551
1920.....	1,272	168	1,440	....	....	....	....
1921.....	1,275	39	1,314	361	....	361	1,675
1922.....	676	144	820	71	....	71	891
1923.....	1,507	29	1,536	....	....	....	....
1924.....	2,150	63	2,213	167	....	167	2,380
1925.....	2,363	50	2,413	....	....	....	....
1926.....	2,184	102	2,286	285	....	285	2,571
1927.....	1,785	50	1,835	126	....	126	1,961
1928.....	1,356	15	1,371	237	....	237	1,608

New forms of cooling mediums for refrigerator cars received considerable attention during 1928. Silica gel has passed from the experimental stage, and is now employed in 30 refrigerator cars. Solid carbon dioxide, also known as dry ice, is receiving considerable attention as a substitute for water ice in refrigerator cars. It has not, however, reached the stage of commercially practicable application, but recent developments are such that this may be possible in the near future.

Table VI—Types of Passenger Equipment Ordered for Use in the United States and Canada

Type	1925	1926	1927	1928
Coach, combination, passenger, etc.....	650	432	760	553
Multiple unit coaches and trailers.....	82	237	52	30
Sleeping, parlor, chair, etc.....	535	542	238	322
Dining	112	111	111	123
Baggage, express, mail.....	739	435	422	502
Express refrigerator	10	125	2	30
Milk	80	60	45	600
Horse	16	95	17	49
Private, business, miscellaneous.....	17	67	108	55
Total	2,241	2,104	1,755	2,264

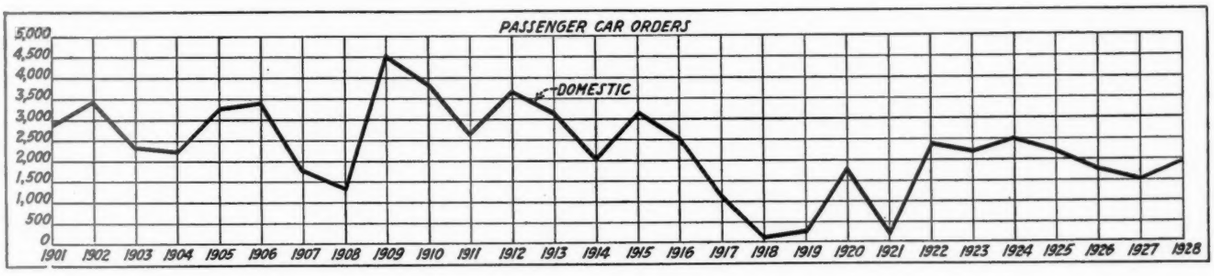
Passenger Cars

The number of passenger cars built for use in the United States last year was 1,356. This total was 429 cars less than in 1927 and, in fact, the lowest number of cars built since 1922. Passenger cars built for Canadian service last year totaled 237, as compared with 126 in 1927 and 285 cars in 1926. Table V shows the number of passenger cars built in the United States and Canada since 1913.

Table VI shows the types of passenger equipment ordered for service in the United States and Canada for the years 1925 to 1928, inclusive. A total of 2,264 passenger train cars was ordered in 1928. Of this total, 600 cars, or 26.5 per cent, were express refrigerator cars, and 553, or 24.4 per cent, were coaches and combination passenger cars for general day-coach service, equipped only with the customary seats and toilet facilities. A total of 502 cars, or 22.2 per cent of the total ordered, were for baggage, express or mail service. As in previous years, orders for sleeping, parlor and chair cars form a fair percentage of the total number ordered. In 1928, the orders for this type of equipment totaled 322, or 14.2 per cent.

Table VII—Comparison of Rail Motor Car Weights, U. S. and Canada

Weights	1925	1926	1927	1928
25,000 lb. and under.....	6	7	..	..
Over 25,000 lb. to and including 50,000 lb.....	19	7	..	..
Over 50,000 lb. to and including 75,000 lb.....	74	2	4	..
Over 75,000 lb. to and including 100,000 lb.....	27	79	29	5
Over 100,000 lb. to and including 125,000 lb.....	7	32	88	65
Over 125,000 lb. to and including 150,000 lb.....	..	5	21	52
Over 150,000 lb.....	..	1	..	9
Unclassified	..	..	26	22

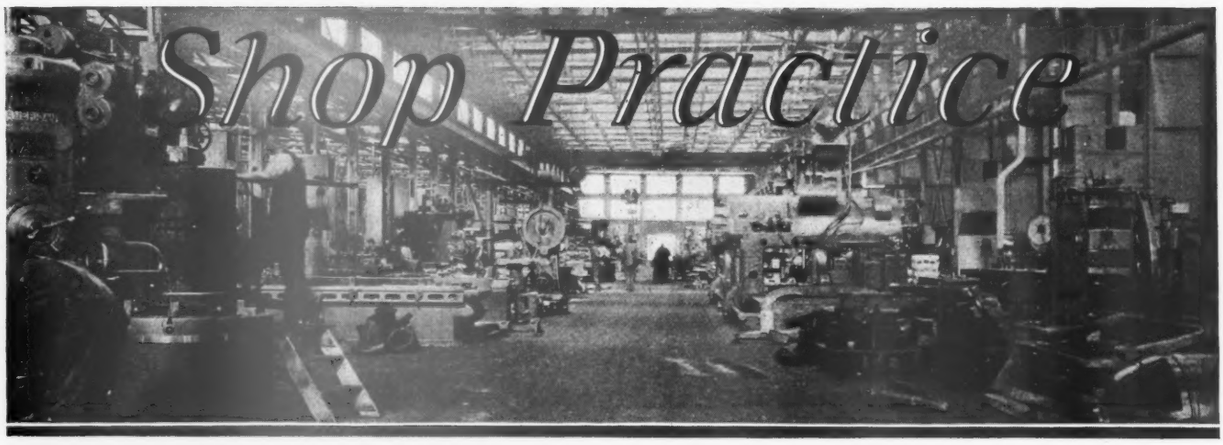


Passenger car orders, 1901 to 1928

Two orders placed by the Pennsylvania formed the bulk of last year's passenger car business. These two orders, one for 600 cars and the other for 550 cars, are two of the largest passenger car orders on record. These two orders by the Pennsylvania, totaling 1,150 cars, account for nearly 51 per cent of the number of cars ordered for service in the United States and Canada. These large orders were placed for the purpose of carrying out the plans of that road to replace all cars of wood construction with steel equipment on all regular passenger trains throughout the system.

The past year has seen the establishment of the roller bearing in the passenger car field, and its use is being rapidly extended. The tendency to pay close attention to esthetic considerations in interior decoration as well as to give consideration to elements of comfort and convenience for the coach passenger, is becoming more general.

NICKEL-CHROME STEEL.—Data, in the form of charts and tables with explanatory comment, covering the results of extensive tests showing that the properties of S.A.E. 3130 nickel-chrome steel vary less from heat to heat than those of other commercial steels, are contained in the eight-page bulletin of the International Nickel Company, Inc., 67 Wall Street, New York. The bulletin is entitled "Torsion, Impact and Other Mechanical Properties of S.A.E. 3130 Nickel-Chrome Steel."



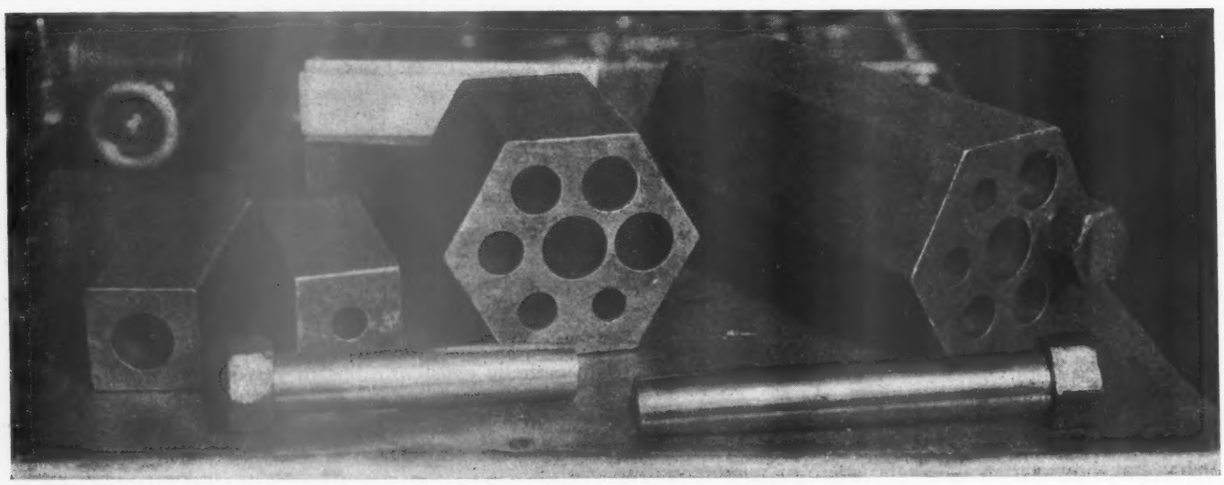
Manufacturing and Gaging Taper Frame Bolts*

The use of the proper types of gages is essential for correct machining and fitting

Part I

TAPER frame bolts are not particularly difficult to manufacture. The problem is to manufacture them economically in the numerous diameters and lengths required for locomotive repairs.

It is not the purpose of this article to enter into a detailed discussion of the relative merits, cost, or desirability of manufacturing in the central production shop, the local shop, or of purchasing the bolts from an outside manufacturer. The purchasing of taper bolts from a manufacturer is dependent upon location, promptness in filling orders, the time required for the transmittal of requisitions from the railroad shop to the manufacturer and the willingness of the manufacturer to make up small lots of odd sizes. If the manufacturer is located within local telephone distance and is willing to make frequent deliveries, it is then permissible for the repair shop to order direct on the manufacturer. If the bolts can be obtained in a reasonable time after placing the orders—say two weeks—it is entirely possible for the railroads to purchase from manufacturers, or for the central production shop to supply the more common sizes required. However, under the most favorable conditions, it is generally necessary for the local shops



Internal gages used for gaging taper frame bolts

* The author of this article, who is now deceased, was an expert in railway shop production methods. Although he had been a regular contributor to the *Railway Mechanical Engineer* over many years, at his own request his articles were always published under a *nom de plume*.

A portable lathe used for machining taper frame bolts in the erecting shop

to maintain at least a skeleton organization for the final finishing or altering of the stock sizes of bolts in order to meet the every-day repair requirements. A careful analysis in the larger railroad shops will generally show that from 500 to 1,000 sizes of taper frame bolts are required to meet all of the demands of locomotive repair work. To keep all of these sizes in stock is difficult and materially increases stock inventory. Therefore, any system which admits of economical manufacture to certain step sizes should be welcomed.

It is common practice in the locomotive erecting shop to ream the holes in the frames, cylinders, etc. to step-size gages and from the markings on the gages make up a bill of bolts, showing all of the sizes required. The bill of sizes is sent to the bolt shop where the bolts called for are finished to size. This practice necessitates the use of external gages for the holes and internal gages for the bolts.

It is also important that the taper on the bolt be a perfect fit in the hole for the entire tapered surface to insure that the two members held together by the bolt will not move on each other, as the most minute movement is soon augmented, resulting in rapid wear owing to the severe strains set up by the rapidly reciprocating pistons. Actually, a taper frame bolt should be considered and manufactured more in the light of a taper pin, because its prime object is to prevent the moving of two members held together.

The following bolt data will serve to call attention to the close measurements necessary to insure the proper fitting of taper frame bolts:

The taper mostly used is 1-16 in. per foot. The taper per inch is .0052 in., plus. The taper per ¼ in. is .0013 in., plus. The ratio of length to taper per foot is 192 to 1. Each .001 in. difference in diameter of the bolt makes a difference in the drive of .192 in., or .005 in. more than 3-16 in. Three inches in length equals 1-64 in. difference in diameter.

It is largely a question of judgment as to how much a taper bolt should be driven home after forcing it in the hole by hand. The above data show that each .001 in. diameter effects the drive 3-16 in.; therefore, the bolt should be manufactured well within a .001-in. limit.

Up to the present time no suitable micrometer has been made available for measuring tapered holes, or the bolt diameter, and it would appear difficult to design a micrometer for either purpose. There are several methods now in use for measuring the diameter of taper bolts and holes.

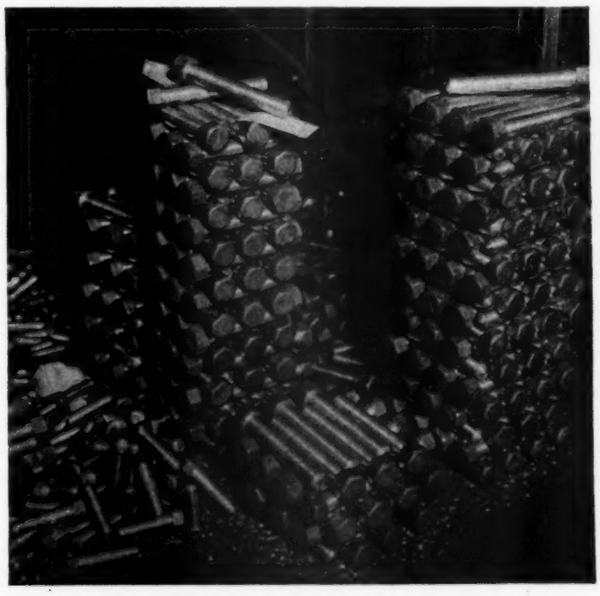
Round Plug Gages

The most commonly used gage is the round plug type which is of the same taper per foot (generally 1-16 in.) as the reamers. Circular lines are spaced 3 in. apart around the gage body. These lines agree with a difference in diameter of 1/64 in. Each line is marked showing the actual diameter by some designating marking or number. The gages are from 15 in. to 18 in. long from the point to the end of the handle. These gages in many respects, are very desirable as the holes may be measured both for diameter and correctness of taper and, in addition, they serve as master standards.

This type of gage has certain objections from the erecting-shop point of view. The holes must be thoroughly cleaned and all chips removed, as the smallest accumulation of dirt will affect the results. They are heavy and cumbersome to carry around the shop as each gage weighs from five to six pounds. A gage 18 in. long will answer only for five 1/64 in. step sizes and a 15 in. gage for four 1/64 in. step sizes. To cover the range from 1 in. to 1½ in. diameters requires seven gages.

A flat form of internal taper gage is now used to good advantage for locomotive repair work, although to the best of the writer's knowledge this form has never been placed in service for taper-bolt work. This type of gage can be made from rectangular tool steel, marked with lines spaced 3 in. apart, stamped, hardened and ground similar to the round plug gage, or the gages can be made in the round form and the two sides milled to the required thickness.

The advantages of the flat form of gage over that of the round form are that the weight is reduced about



Taper frame bolts ready to be threaded

one-half and, therefore, a greater number may be conveniently carried about the shops. It is not as necessary to clean the holes carefully when using this form of gage as a slight turn of the gage in the hole is generally sufficient, for all practical purposes, to remove chips or dirt. An improperly reamed hole is indicated by the side shake or rock of the gage in the hole. This gage would, therefore, be the more convenient for checking reamed holes than the round gage.

An inexpensive design of internal gage for taper frame bolts, used principally in the bolt shop, is made from a hexagon block of cast iron about 2 in. over the flats. The block is bored and reamed for seven sizes of holes varying by 1/64 in. or 1/32 in. The size of the larger ends of the holes is stamped adjacent to the holes. Where 1/64 in. step sizes are used, the bolts are finished so that the heads extend from the face of the gage to allow for the necessary drive when applying. The amount allowed for driving may be 3/16 in., ¼ in. or more, depending on practices. Where the sizes vary by 1/32 in. steps, the heads extend 3 in., plus the amount for drive. This form of gage is also used in the tool room for inspection purpose and when grinding reamers.

A gage of this type, when reamed to the correct taper, is accurate enough for all practical purposes.

In the event of wear of one or more of the holes, the gage can be refaced and rereamed, resulting in a better gage owing to the aging of the metal. Accurate gages are drilled and allowed to season by laying in the weather for the longest possible time previous to the final reaming.

In some railroad shops, ring internal gages are used for gaging taper bolts or grinding reamers. These are made of tool steel, stamped, hardened and internally ground and make a most excellent form of gage admitting of close measurements. They are expensive, however, owing to the fact that from 30 to 50 are required. In practice, two gages differing in internal diameter by 1/64 in. are placed on the bolt, or reamer and the distance from face to face measured. The distance should be exactly 3 in. for 1/16 in. taper per foot. When checking for 6 in. lengths, gages varying by 1/32 in. are used.

Use of Gages

The plug form of gage is used in the following manner: A tapered hole is reamed until one of the lines on the gage comes flush with the outer surface of the member reamed. The size marked on the gage indicates the size of the hole, which is set down on the bill of bolts. The flat form of gage is used in a similar manner. This is satisfactory as far as size is concerned. With the round form of gage, however, it is generally necessary to clean the holes carefully to insure accuracy. With the flat form, a slight turn of the gage will generally remove the chips.

The taper frame-bolt gage for use in the erecting shop, is used as follows: Preparatory to rereaming a hole, the reamer is pushed in the hole until tight. A chalk mark is made on the reamer where it is flush with the outer edge of the hole. The reamer is removed and placed in a suitable hole in the gage. The hole selected is possibly 1/32 in. larger than the reamer at the previously chalked location. The reamer is then chalked near the face of the gage. A fine pencil line is drawn on the chalked surface of the reamer agreeing with the face of the gage. By using both the face of the gage and 3 in. out from it, it is possible to reduce the number of holes in the gage by one-half. The taper hole in the frame is then reamed until the pencil line comes flush. The marking on the face of the gage shows the size of the bolt required, which is set down on the bill of bolts. This method, which may appear crude, works out well in practice. However, care is necessary to maintain the reamers to the proper taper, and also to mark the reamer accurately at the time of entering it into the gage block and to stop the reaming at the correct point.

Supplying the large and moderately-sized railroad shops with sets of interchangeable gages, has several advantages. The gages provide universal standards for the taper per foot, which will insure greater accuracy when grinding taper reamers. As a result of properly ground reamers, where a hole is reamed in one shop and later rereamed in another shop, it is not necessary to enlarge the hole as much as would be the case where the reamers in the two shops do not agree. Properly ground reamers and external gages make it entirely feasible to ream the holes to step sizes in the erecting shop and to prepare a bill of bolts and from the sizes set down, from which the bolt shop can finish the bolts to the correct size so that they can be properly driven in the tapered holes.

Taper frame bolts are sometimes designated by arbitrary numbers or symbols agreeing with the markings on the gages, which do not indicate the bolt diameter. As an example, consider a bolt 8 in. long by 1⅛ in. at the largest diameter, with 1 in. threads. This may be called an 8-14-1 bolt, referring respectively to the length, the gage number and the thread size. In many respects, in these days of convenient measuring devices, it is more desirable to designate the length and diameter under the bolt head in steps of 1/32 in. or 1/64 in. As an example, a bolt 8 in. long and 1 9/64 in. in diameter would be designated as 8-1 9/64, or for brevity, 8-1-9, the first figure indicating the length, the second the even inchs of the diameter and the third the sixty-fourths. This would cover the majority of bolts.

Establishing standard step sizes for bolts that should be stocked greatly simplifies ordering in the local shops, ordering from one shop on another or from a bolt manufacturer. The greatest advantage is the more proper fitting which invariably follows as a result of supplying the workman with proper reamers, gages and appliances.

(The concluding installment will discuss methods of manufacture.)

A Sturdy Tool Holder for Slotters

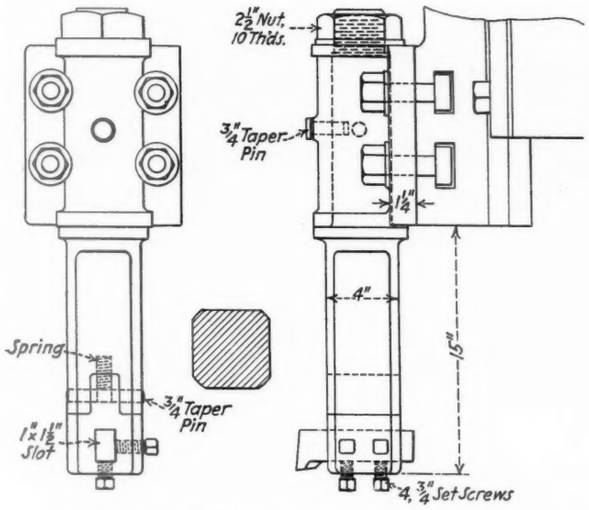
By F. Rattek

IN one of the back issues of the *Railway Mechanical Engineer,* an article described and illustrated a method of machining locomotive driving boxes on a slotter. One of the views showed a slotter bar about 2¼ in. in diameter and 20 in. long. The use of a long, slender slotter bar is poor practice and inefficient, as the bar is prone to vibrate, resulting in a loss of time and a poorly finished surface.

The slotter is still a widely used machine in the smaller railway shops where the small volume of work does not justify the purchase of more modern machine tools that have been designed to handle work commonly

done on a slotter. The best fixture and tools that can be obtained should be used on a slotter. In the shop where I am employed, the slender slotter bars have been replaced with sturdy bars, such as shown in the illustration. A circular bracket, which has a 3-in. hole throughout its length, is bolted to the lower end of the slotter ram. The upper end of the slotter bar is slid into the bracket and a 2½-in. nut drawn tight in the projecting end of the bar. A ¾-in. taper pin is driven through the bracket into the boring bar to prevent the bar from turning.

The lower part of the bar is formed into a 4-in. square. The part in which the cutting tool is held by



A slotter tool holder designed to prevent chatter

four ¾-in. set screws, can be removed from the bar by removing a taper pin. When this pin is driven home, it compresses a small coil spring set in a pocket, which extends into the removable tool holder and the main section of the bar. The purpose of this spring is to help prevent the taper pin from working out while the machine is in operation. No vibration or chatter takes place in a bar of this design. Another advantage of this bar is that the large heavy cutting tools commonly used are replaced by much smaller tools, which results in a considerable saving in tool steel.

One Use for a Left-Hand Drill

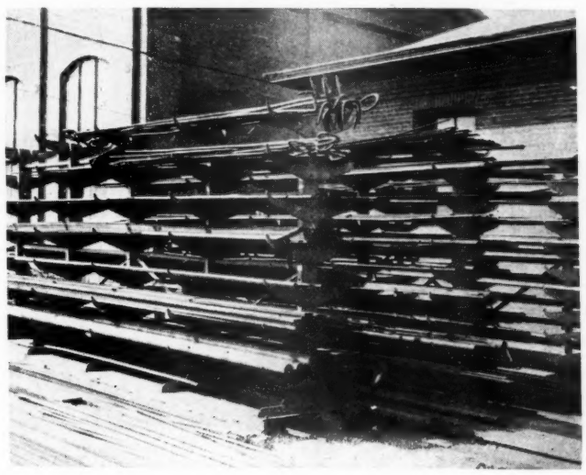
OCCASIONALLY, the grease plugs or set screws, as they are sometimes called, break off in the ends of the crosshead pins. Frequently, they are screwed in so tight that it is difficult to back them out. Undertaking to drill them out with an ordinary drill is sometimes unsuccessful, owing to the fact that the plug will screw further down into the pin. To overcome this difficulty, make a good left-hand twist drill of the same size as the right-hand drill ordinarily used. By using this drill and by reversing the drill press spindle, the plug will back out of the hole or can be drilled out just as easily, if the plug sticks, as with a right-hand drill.

Left-hand drills have been used for this particular job very successfully.

Storage Rack for Steel Rods and Pipe

LONG pipes and steel rods are material difficult to store in an orderly manner on the storage platform. The racks shown in the illustration, which are used at the Denver shops of the Colorado & Southern, not only keep such material in order, but make it easily accessible.

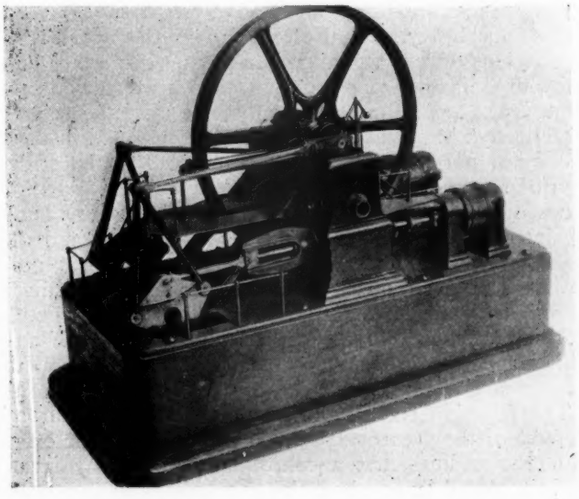
Each rack is made of five upright sections of 4-in.



Long pieces of bars and pipe can be easily stored in a rack of this design

channel iron. These are connected lengthwise by three ¾-in. rods, passed through sections of 1½-in. pipe and tightened with heavy nuts at the ends. A 4-in. angle, welded to the bottom end of each upright, forms the base. Ten 30-in. sections of ½-in. steel, turned up at each end and 6 in. deep in the middle, are welded to the flat side of the upright channels. These racks are 14 ft. long and 6 ft. high.

* * *



Original patent model of the Corliss pumping engine which is preserved in the National Museum, Washington, D. C.

Airplane view of modern-equipped Illinois Central shops at Paducah, Ky.

Paducah Repair Shop Operation Meets Expectations

Magnitude of new Illinois Central plant presents unusual problems now largely solved—Full output developed

By Lee Robinson
Shop Engineer, Illinois Central, Chicago

Part I

ON September 1, 1927, the Illinois Central placed in operation new locomotive repair shops at Paducah, Ky., and also certain facilities which form the nucleus of a large car-repair plant. An entire new shop organization was built up and the results of the first year's operation have fully met all expectations. Practically all machine-tool equipment installed in these shops was purchased new and represented the latest design of heavy-duty machinery then available. Opening shops of the magnitude of those at Paducah, involving the introduction of new methods and practices and the development of new forces, brought out many new problems not previously encountered. However, these were quickly adjusted and the plant placed on a smooth working basis within a year of the opening date and with an increased output each month comparable with the increase in forces.

The Illinois Central, like many of the large railroad systems of the present day comprises not only the original charter lines, but a consolidation of many small roads acquired by purchase, lease or other methods. In many cases, repair shop facilities constituted part of the fixed property of these roads and they continued to be operated as such for the purpose of making heavy repairs to engines and cars.

Naturally, some of these shops were very old as will be seen from the following tabulation which represents the points at which heavy repairs were being performed as late as 1927, and while they were serving their purpose to the extent of their capacity, it was only by reason of making large yearly replacements and additions of modern machine tools and mechanical labor-saving devices that the output of these shops could be kept up with the requirements.

	Date built
Water Valley, Miss.	1867
E. St. Louis, Ill.	1875
Paducah, Ky. (Old Shops)	1880
Mattoon, Ill.	1880
McComb, Miss.	1888
Vicksburg, Miss.	1890
Freeport, Ill.	1892*
Burnside, Ill.	1893
Waterloo, Ia.	1901
Memphis, Tenn.	1903
Clinton, Ill.	1904

* Date acquired.

The ages of these shops at the time the new shops at Paducah opened covers a range of 23 to 60 years. When it is considered that the main shops at Burnside,

Ill., which were the largest on the system prior to the construction of the new facilities at Paducah, were 34 years old and that the size and weight of locomotives have continually increased, particularly in the past 10 years, it is readily apparent why the Illinois Central built new shops. It was simply a matter of necessity as the locomotives purchased in more recent years were so large they could not be placed in the then existing shop buildings.

At the time Burnside shops were built, the largest locomotive owned was a Consolidation, 2-8-0 type, 35 ft. 6¼ in. over all in length and weighing 137,300 lb. In 1927, the larger engines were:

Type	Length	Weight
2-6-6-2	62 ft. 7 in.	438,000 lb.
2-10-2	56 ft. 8¾ in.	382,000 lb.
2-8-4	55 ft. 1½ in.	388,000 lb.
4-8-2	56 ft. ¾ in.	367,500 lb.

There has been a maximum increase of 76.3 per cent in length and 219 per cent in weight.

The Illinois Central System is divided generally into two grand divisions by the Ohio River. Burnside shops serve the territory north of the river except for those locomotives which are too large for the shops to accommodate. Paducah shops serve all of the territory south of the river as well as those large locomotives which cannot be handled at Burnside.

Why Shops Were Located at Paducah

There were several advantages accruing to the railroad which influenced the selection of Paducah for the location of the new shops. It is on the main line from Louisville to New Orleans readily accessible to all points in the Southern district and also within reasonable distance of points on the Northern district. It is a city of good size presenting favorable housing and living conditions for the workmen and has a fairly even climate. The company owned considerable property which could be utilized to good advantage for shop purposes and which permitted purchasing less additional land than would have been the case if these shops had been located at some other point on the system.

Ground was first broken for the new shops, March 31, 1925, and they were opened for operation in September, 1927. The locomotive group consists of four main buildings: Machine and erecting shop, boiler shop, blacksmith shop and tank and paint shop; also a lesser set of buildings consisting of a paint- and carpenter-shop building, a combination pipe, tin, air brake and electrical shop, the flue shop located in one end of the iron-storage building, brass foundry and two toilet, wash-room and locker buildings. The storehouse, oil house and paint-storage building, iron-storage building and power house serve both the locomotive and car departments. The general layout provides for future extension to all shop buildings within predetermined limits.

Description of Machine Shop

The machine shop is of the transverse type and is 245 ft. wide by 681 ft. long, having an erecting bay 95 ft. wide, a heavy-machine bay 85 ft. wide and a light-machine bay 65 ft. wide. There are 25 working pits on the erecting side, spaced 24 ft. on centers, and two additional tracks at the east end, one being the entrance and stripping track and the other the assembling and exit track. This bay is served by one 250-ton traveling gap crane for moving engines overhead and two 15-ton traveling cranes for handling material. The heavy-machine bay is served by two 15-ton overhead traveling cranes and provision is made in the light-machine bay for monorail trolleys and post jib cranes with air and electric hoists as needed. In the center of the shop is located a wire enclosed tool crib with suitable serving counters. In this tool crib is also the distribution switch board for this shop and directly overhead on a small balcony are two motor-generator sets for furnishing d.c. current for operating those particular tools using direct current. On the north side of the building centrally located, is a balcony containing offices for the general machine shop foreman and all sub-foremen, from which a view of the entire shop is afforded. Inasmuch as all machine tools in this shop as well as all the other shops are individually motor driven, there are no belts or line shafting to obstruct the vision. The

Battery of three 6-ft. radial drills for frame work

shop is heated by means of unit heaters of the balanced fan type, thermostatically controlled and so arranged as to maintain as near uniform temperature throughout the shop as possible.

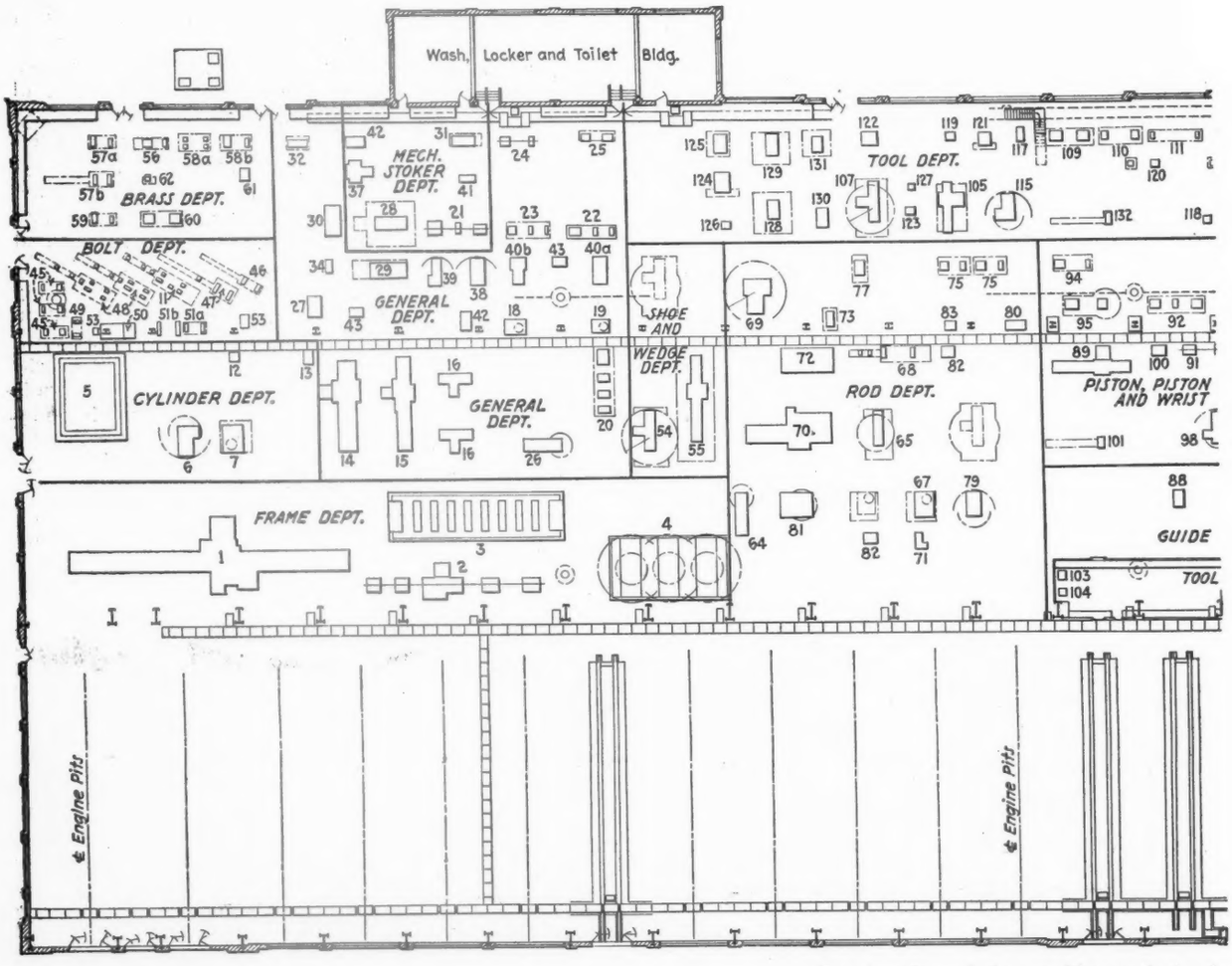
A maximum amount of natural light is provided by the large window area on the side and end walls and through the roof skylights. These skylights are of special design, being A-shaped stradling each truss. They are hinged at the top and open outward from the bottom. Pivoted ventilating sashes are also incorporated in the wall windows. All of the skylights and the ventilating sashes at the top of the windows are motor-operated with push-button controls placed at convenient locations throughout the shop. This arrangement assures the best natural circulation and ventilation possible. The windows and skylights on the south and west exposure have actinic glass to diffuse the sunlight.

Artificial light is supplied by 300-watt electric lamps. Light is diffused by enameled-steel shades and lamps, spaced to give uniform illumination throughout the shop, are mounted overhead on the line of the truss and on the side walls. There are three lamps per panel of the light-machine bay, four per panel of heavy-machine bay and four per panel of the erecting bay.

The machine-tool equipment is divided into groups, or departments, according to the kind and class of work to be performed. Attention was given to the relation of the groups so that, where necessary to move work from one group to another, it could be done with a minimum movement. This idea was followed out to the fullest extent the building limitations would permit.

Each group is supplied with a full complement of tools to make it self-sustaining in performing the work assigned to it with the exception that where similar machines were needed in two groups, neither one of which would be operating full time, one machine was provided and located to serve both groups, avoiding unnecessary duplications and obtaining the maximum service from the machine tool. Generous floor space and wide communicating lanes are provided throughout the shop.

There are 13 groups which, together with the machines assigned to each group, the number and horse power of the motors and kind of current used, are listed as in a table.



The location of the machine tools in the

Both the entrance and exit tracks are at the east end of the shop. An additional track is located between these two tracks which extends through the shop to the north side of the building where the lye vats are located. As the engine is stripped, the parts to be cleaned are placed in baskets and moved by trucks to the lye vats. However, the parts are segregated in different baskets according to the group handling these particular parts and, when cleaned, move intact direct to that particular group. The driving-wheel and driving-box departments are located in this end of the shop so that the movement of these many large and heavy parts on every

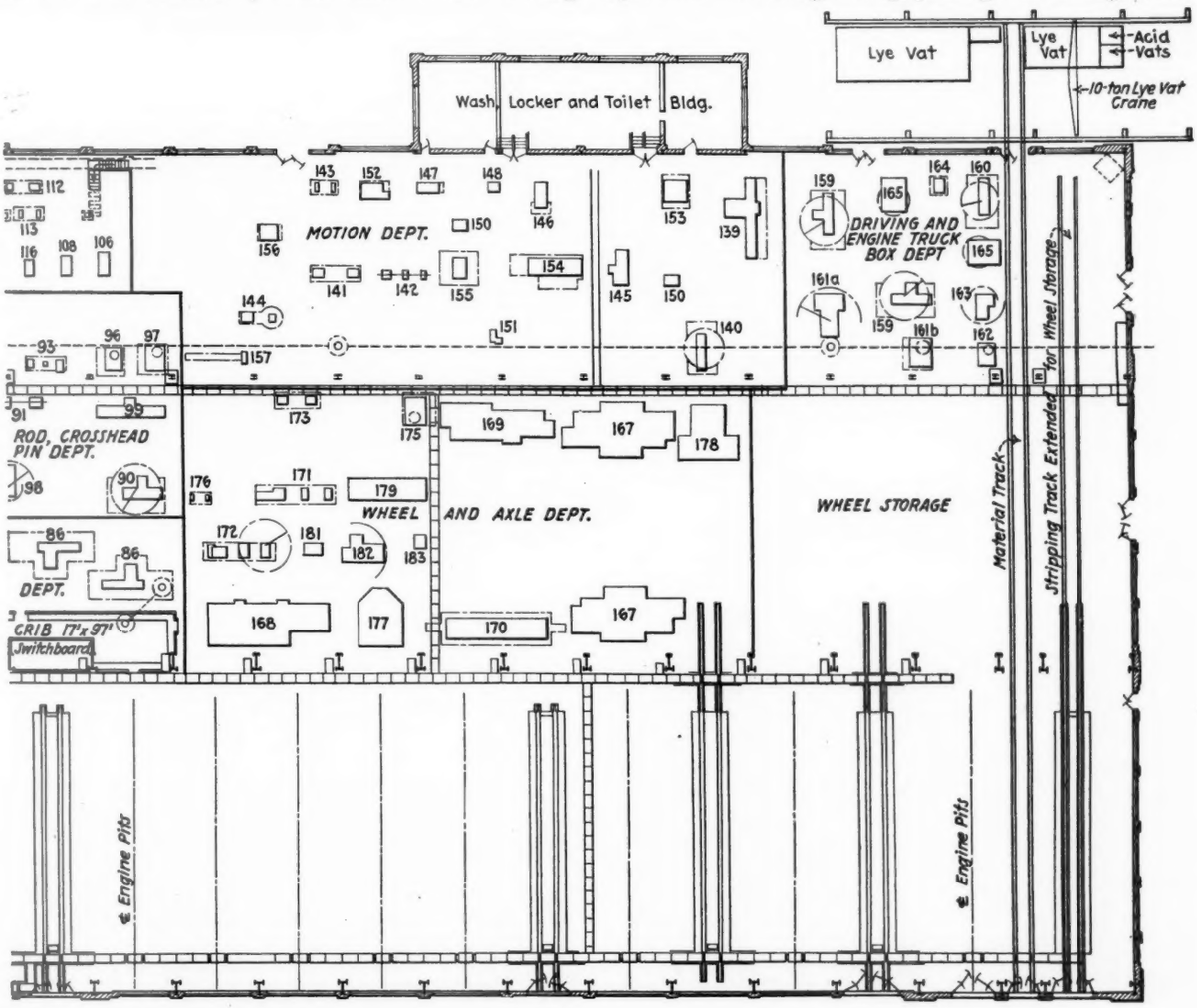
locomotive from the time it is unwheeled on the stripping track to the time it is wheeled on the exit track is reduced to the minimum.

The motion-work department located adjacent to the driving-box department is also convenient to the lye vat with machinery arranged to cut out back movement of the repair parts. The same may be said of the piston-rod and guide departments in the center of the shop. From the rod department, equipped with the latest machinery for handling this class of work, rods can be readily handled by crane to locomotives in any part of the erecting shop. The frame and cylinder departments are adjacent to the erecting shop in the west end of the building, from which end heavy frames and cylinders can be handled by crane either to the erecting shop or through a door to the material-storage platforms and 20-ton overhead traveling crane, just outside the west end of the shop. The importance of segregating mechanical stoker repairs has been recognized and necessary machinery for this purpose located in a department by itself, as shown on the drawing. A fully equipped brass department occupies the northwest corner of the building. Between it and the cylinder department is the bolt department, equipped with modern turret lathes, bolt and screw machines.

The facilities for washing and cleaning dirty engine parts consist of two concrete tanks, one 12 ft. wide by 10 ft. deep by 30 ft. long and one 9½ ft. wide by 6 ft. deep by 15 ft. long, and two small lead-lined compartments, 3½ ft. wide by 3 ft. deep by 4½ ft. long, for acid cleaning. The tops of these tanks are 3 ft. above the floor and are supplied with sectional sheet-metal covers hinged and counterbalanced. A concrete washing and drain floor covers the space between the tanks and the machine shop building and the entire area is served by a 10-ton traveling crane with single trolley and operated by pendant cords from the floor.

Machine Tool Features of Special Interest

The Morton cylinder machine designed primarily for finishing locomotive cylinders, permits performing all operations of boring, facing, planing and milling, neces-

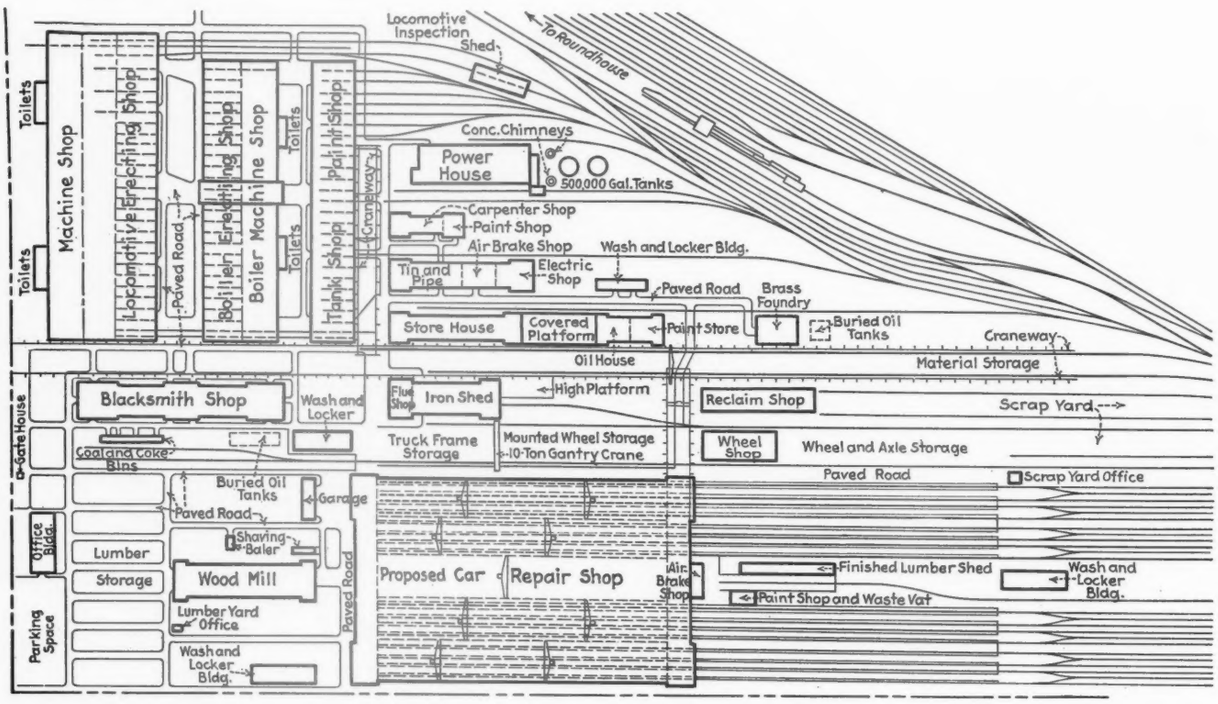


machine and erecting shops

sary to finish cylinders complete, except stud-hole drilling. All of these operations can be made with two set-ups, whereas, the previous methods employed with the equipment available, required five set-ups. This has effected about a 50 per cent reduction in time of machining cylinders. The design and construction of the machine provides for an independently operating boring unit which allows two operations to be carried on simultaneously. On account of the great flexibility of this machine, it is adaptable for machining difficult heavy parts, such as deck castings, frame cross braces, mud rings and special machining on wheel centers.

The battery of three 6-ft. American radial drills is arranged to accommodate any drilling operations on engine frames. A narrow pit is provided along one side of the battery and extra drilling tables are furnished

4	3—Radial drills, 6 ft. (7 ft. reach) (Frame drilling machine)	3— 15 hp.—a.c.
	CYLINDER AND STEAM CHEST (PISTON VALVE) DEPARTMENT	
5	1—Morton 72 in. traveling head cylinder borer and planer	1— 10 hp.—a.c.



Plan of the general repair shops at Paducah, Ky.

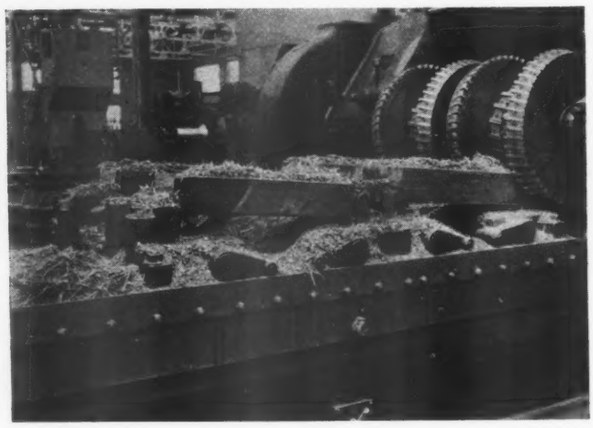
with each machine for holding frames in place in or above the pit. The opposite side of the machines, which

Ingenious set-up of work on the magnetic chuck of modern surface grinder

The Tools in the Machine Shop

FRAME DEPARTMENT

Item no.	No. units	Machine	Motor
1	1	Frame planer, 84 in. by 36 in. by 40 ft.	1—75 hp.—main drive d.c. 1—7½ hp.—rail elevating d.c. 1—2 hp.—oil pump d.c.
2	1	Frame planer, 48 in. by 48 in. by 28 ft.	1— 25 hp.—main drive d.c. 1—3½ hp.—rail elevating d.c.
3	1	Double-head frame slotter, 32 in. by 72 in. by 50 ft.	1— 25 hp.—main drive d.c. 1— 20 hp.—main drive d.c. 2—7½ hp.—head motors d.c.
			1— 7 hp.—a.c.
6	1	Plain radial drill, 5 ft.	1— 15 hp.—a.c.
7	1	Vertical turret lathe, 54 in.	1— 15 hp.—a.c.
11	1	J. & L. turret lathe, 3 ft. by 36 in.	1— 5 hp.—a.c.
12	1	Dbl. floor grinder, 18 in. by 3 in.	1— 5 hp.—a.c.
13	1	Upright drill, 24 in.	1— 5 hp.—a.c.
		GENERAL DEPARTMENT—STEAM CHEST, VALVE STEM & YOKE (SLIDE VALVE)	
14	1	Standard planer 62 in. by 62 in. by 12 ft.	1— 50 hp.—main drive d.c. 1— 5 hp.—rail elevating a.c.
15	1	Standard planer 36 in. by 36 in. by 12 ft.	1— 20 hp.—main drive d.c. 1— 3 hp.—rail elevating d.c.
16	2	Draw-cut shapers, 36 in.	2— 15 hp.—a.c.



Set-up for production milling of shoes and wedges

18	1	Vertical turret lathe, 36 in.	1— 10 hp.—a.c.
19	1	Vertical turret lathe, 24 in.	1—7½ hp.—a.c.
20	1	Engine lathe, 36 in. by 18 ft.	1— 15 hp.—main drive a.c. 1— 1 hp.—compound pump a.c.
21	1	Engine lathe, 24 in. by 16 ft. (Stoker Dept.)	1— 10 hp.—a.c.

22	1—Engine lathe, 20 in. by 12 ft.	1— 5 hp.—a.c.
23	1—Engine lathe, 18 in. by 11 ft.	1— 5 hp.—a.c.
24	1—Engine lathe, 16 in. by 8 ft.	1— 3 hp.—a.c.
25	1—Engine lathe, 12 in. by 8 ft.	1— 2 hp.—a.c.
26	1—Slotter, 20 in.	1— 15 hp.—main drive a.c. 1— 1 hp.—compound pump a.c.
27	1—Universal milling machine, No. 4 B	1— 15 hp.—a.c.
28	1—Horizontal boring mill (Stoker Dept.)	1— 3 hp.—a.c.
29	1—Horizontal boring mill	1—7½ hp.—a.c.

Electric babbitt pot with automatic temperature control

30	1—Cold saw, 12 in.	1— 15 hp.—a.c.
31	1—Shaper, 24 in. (Stoker Dept.)	1—7½ hp.—a.c.
32	1—Automatic gear cutter, No. 36 B	1— 3 hp.—a.c.
34	1—Metal saw, 9 in. by 9 in...	1—1½ hp.—a.c.
	1—Arbor press, No. 3 R (Hand operated)	
	1—Arbor press, No. 5 (Hand operated)	
37	1—100 ton Forcing press (Stoker Dept.)	1— 5 hp.—a.c.
38	1—Radial drill, 3 ft.	1— 5 hp.—a.c.
39	1—Radial drill, 5 ft.	1—7½ hp.—a.c.
40a	1—Heavy-duty drill, 36 in.	1— 15 hp.—a.c.
40b	1—Heavy-duty drill, 36 in.	1— 15 hp.—a.c.
41	1—Upright drill, 24 in.	1— 2 hp.—a.c.
42	2—Column-type drills, 25 in...	2— 1 hp.—a.c.
43*	2—Dbl. floor grinders, 18 in. by 3 in.	2— 6 hp.—a.c.
	1—Babbitt furnace (Electric)	
	Bolt Department	
45	3—Engine lathes, 11 in. by 6 ft.	3— 3 hp.—a.c.
46	1—W. & S. turret lathe, No. 2	1— 2 hp.—a.c.
47	1—Foster turret lathe, No. 5.	1— 3 hp.—a.c.
48	2—J & L turret lathes, 2¼ in. by 24 in.	2— 5 hp.—a.c.
49	1—2-spdl. centering machine, 4 in.	1—1½ hp.—a.c.
50	1—Dbl.-head bolt cutter, 2½ in.	1—7½ hp.—a.c.
51a	1—Bolt centering, facing and pointing machine	1—7½ hp.—a.c.
51b	1—4-spdl. vertical taper bolt turner	1— 2 hp.—a.c.
53	2—Upright sensitive drills	2— 1 hp.—a.c.
	Shoe and Wedge Department	
54	1—Draw cut shaper, 36 in. (Pillar type)	1— 15 hp.—a.c.
55	1—Milling machine, 30 in. by 30 in. by 16 ft.	1— 40 hp.—a.c.
	Brass Department	
56	1—Full Universal Monitor lathe, 20 in. by 72 in.	1— 5 hp.—a.c.
57a	1—Universal monitor lathe, 15 in.	1— 2 hp.—a.c.
57b	1—Universal monitor lathe, No. 4	1— 3 hp.—a.c.
58a	1—Brass lathe, 20 in.	1— 5 hp.—a.c.
58b	1—Brass lathe, 18 in.	1— 3 hp.—a.c.
59	1—Brass lathe, 15 in.	1— 2 hp.—a.c.
60	1—Engine lathe, 20 in. by 10 ft.	1— 5 hp.—a.c.
61	1—Upright sensitive drill	1— 1 hp.—a.c.
62	1—Centerless grinding machine	1— 1 hp.—a.c.
	Rod Department	
64	1—Slotter, 20 in.	1— 15 hp.—main drive a.c. 1— 1 hp.—power traverse a.c.
65	1—Draw-cut shaper, 30 in.	1— 10 hp.—a.c.
67	1—Vertical turret lathe, 42 in.	1— 15 hp.—a.c.
68	1—Flat turret lathe, 3½ in. by 44 in.	1—7½ hp.—a.c.
69	1—Vertical milling machine (Rod ends), 54 in.	1— 25 hp.—a.c.
70	1—Heavy rod miller, 54 in. by 30 in. by 16 ft.	1— 75 hp.—a.c.
71	1—Surfacing machine, 36 in. by 16 in.	1— 3 hp.—a.c.
72	1—Rod boring machine (Duplex)	2— 15 hp.—a.c.
73	1—Crank shaper, 16 in.	1— 3 hp.—a.c.
	1—Swing-frame grinder, No. 5	1— 5 hp.—a.c.
75	2—Engine lathes, 21 in. by 8 ft.	2— 10 hp.—a.c.
77	1—Dbl.-head bolt cutter, 2 in..	1— 5 hp.—a.c.
79	1—Radial drill, 48 in.	1—7½ hp.—main drive a.c. 1— ¾ hp.—compound pump a.c.
80	1—Upright drill, 34 in.	1— 3 hp.—a.c.
81	1—Forcing press, 100 ton	1— 7 hp.—a.c.
82	2—Dbl. floor grinders, 18 in. by 3 in.	2—7½ hp.—a.c.
83	1—Small sensitive drill	1— 1 hp.—a.c.

Paducah Repair Shop Operation Meets Expectation

	Guide Department	
86	2—Guide grinders, 30 in. by 84 in.	2— 40 hp.—a.c.
88	1—Upright drill, heavy-duty, 22 in.	1— 10 hp.—a.c.
	Piston, Piston Rod, Crosshead and Wrist Pin Department	
89	1—Std. planer, 30 in. by 30 in. by 10 ft.	1— 20 hp.—main drive a.c. 1—2½ hp.—rail elevating a.c.
90	1—Draw-cut shaper (pillar type), 36 in.	1— 15 hp.—a.c.
91	1—Engine lathe, 30 in. by 18 ft.	1— 20 hp.—a.c.
92	1—Engine lathe, 24 in. by 14 ft.	1— 15 hp.—a.c.
93, 94	2—Engine lathes, 16 in. by 10 ft.	2— 5 hp.—a.c.
95	1—Libby turret lathe, 26 in...	1— 20 hp.—a.c.
96	1—Vertical turret lathe, 36 in.	1— 10 hp.—a.c.
97	1—Vertical turret lathe, 42 in.	1— 15 hp.—a.c.
98	1—Plain radial drill, 5 ft.	1— 10 hp.—a.c.
99	1—Piston-rod grinder, 16 in. by 40 in. by 120 in.	1— 20 hp.—a.c. 1— 2 hp.—a.c.
100	1—Dbl. floor grinder, 18 in. by 3 in.	1—7½ hp.—a.c.
101	1—Metal saw, 6 in. by 6 in...	1— 1 hp.—a.c.
	Tool Department	
103	1—Dbl. floor grinder, 18 in. by 3 in.	1— 5 hp.—a.c.
104	1—Drill pointer	1— 1 hp.—a.c.
105	1—Heavy duty planer, 30 in. by 30 in. by 6 ft.	1— 10 hp.—main drive d.c. 1— ¾ hp.—rail elevating a.c.
106	1—Crank shaper, 24 in.	1—7½ hp.—a.c.
107	1—Draw cut shaper (pillar type), 36 in.	1— 15 hp.—a.c.
108	1—Slotter, 12 in.	1— 5 hp.—a.c.
109	1—Heavy duty engine lathe, 24 in. by 10 ft.	1— 10 hp.—a.c.

Cylinders are finished complete on this machine in two set-ups

110	1—Toolmaker's lathe, 20 in. by 10 ft.	1— 5 hp.—a.c.
111	1—Engine lathe, 16 in. by 14 ft.	1— 3 hp.—a.c.

112	1—Toolmaker's lathe, 16 in. by 5 ft.	1— 5 hp.—a.c.
113	1—Toolmaker's lathe, 12 in. by 6 ft.	1— 2 hp.—a.c.
115	1—Radial drill, 4 ft.	1— 10 hp.—a.c.
116	1—Upright drill, 24 in.	1— 5 hp.—a.c.
117	1—Upright drill, 21 in.	1— 3 hp.—a.c.
118	1—Sensitive drill, 12 in.	1— ¾ hp.—a.c.
119	1—Dbl. floor grinder, 18 in. by 3 in.	1— 5 hp.—a.c.
120	1—Dbl. floor grinder, 14 in. by 2 in.	1— 3 hp.—a.c.
121	1—Surface grinder, 30 in. by 8 in.	1— 5 hp.—a.c.
122	1—Universal grinder	1— 5 hp.—a.c.
123	1—Tap grinder	1— ¾ hp.—a.c.
124, 125	2—Universal cutter and tool grinders	2— 5 hp.—a.c.
126	1—Drill pointer	1— 1 hp.—a.c.

Double-head frame slotter notable for smoothness of operation

127	1—Chaser grinder	1— ½ hp.—a.c.
128	1—Universal miller, No. 4 A	1— 15 hp.—a.c.
129	1—Vertical miller, No. 4	1— 15 hp.—a.c.
130	1—Universal miller, No. 3	1— 10 hp.—a.c.
131	1—Miller, No. 2 M	1— 5 hp.—a.c.
132	1—Metal saw, 6 in. by 6 in.	1— 1 hp.—a.c.
	1—Arbor press (Hand operated), No. 3 R	
	1—Arbor press (Hand operated), No. 5	

MOTION DEPARTMENT

139	1—Standard planer, 36 in. by 36 in. by 10 ft.	1— 25 hp.—main drive d.c. 1— 3 hp.—rail elevating a.c.
140	1—Draw cut shaper (pillar type), 30 in.	1— 10 hp.—a.c.
141	1—Heavy duty engine lathe, 24 in. by 12 ft.	1— 15 hp.—a.c.
142	1—Engine lathe, 18 in. by 11 ft.	1— 5 hp.—a.c.
143	1—Engine lathe, 14 in. by 6 ft.	1— 3 hp.—a.c.
144	1—Gisholt turret lathe, No. 3 L	1— 15 hp.—a.c.
145	1—Plain radial drill, 4 ft.	1—7½ hp.—a.c.
146	1—Heavy-duty drill, 24 in.	1— 10 hp.—a.c.
147	1—Upright drill, 28 in.	1— 3 hp.—a.c.
148	1—Small sensitive drill	1— 1 hp.—a.c.
150	2—Dbl. floor grinders, 18 in. by 3 in.	2—7½ hp.—a.c.
151	1—Surfacing machine	1— 1 hp.—a.c.
152	1—Plain grinding machine, 10 in. by 36 in.	1—7½ hp.—a.c.
153	1—Radius link grinder	1—7½ hp.—a.c.
154	1—Lucas horizontal boring machine, No. 32	1—7½ hp.—a.c.
155	1—Plain miller, No. 4 B	1— 15 hp.—a.c.
156	1—Forcing press, 50 ton	1— 5 hp.—a.c.
157	1—Metal saw, 6 in. by 6 in.	1— ¾ hp.—a.c.
	1—Arbor press (Hand operated), No. 3 R	

DRIVING BOX AND ENGINE TRUCK BOX DEPARTMENT

159	2—Draw-cut shapers with driving-box attachments, 36 in.	2— 15 hp.—a.c.
160	1—Draw-cut shaper (pillar type), 30 in.	1— 10 hp.—a.c.
161a	1—Driving-box mill, 54 in.	1— 15 hp.—a.c.
161b	1—Driving-box mill, 44 in.	1— 20 hp.—a.c.
162	1—Vertical turret lathe, 36 in.	1— 10 hp.—a.c.
163	1—Plain radial drill, 4 ft.	1— 10 hp.—a.c.
164	1—Lehman oil-groove milling machine, 14 in. by 22 in.	1— 5 hp.—a.c.
165	2—Forcing presses, 100 ton	2—7½ hp.—a.c.
	1—Babbitt furnace (Electric)	

WHEEL AND AXLE DEPARTMENT

167	2—Driving-wheel lathes, 90 in.	2— 50 hp.—main drive a.c. 2—6½ hp.—tail stock a.c.
168	1—Trailer-wheel lathe, 54 in.	1— 50 hp.—main drive a.c. 1— 10 hp.—tail stock a.c.
169	1—Driving-axle journal lathe, 90 in.	1— 15 hp.—main drive a.c. 1— 5 hp.—tail stock a.c.
170	1—Driving-wheel quartering machine, 90 in.	2— 5 hp.—a.c.
171	1—Driving- and trailer-axle lathe	1— 30 hp.—a.c.
172	1—Dbl. axle lathe, No. 3	1— 25 hp.—a.c.
173	1—Crank-pin lathe, 24 in. by 10 ft.	1— 15 hp.—a.c.
175	1—Vertical turret lathe, 54 in.	1— 15 hp.—a.c.
176	1—Single-spindle centering machine, 8 in.	1— 1 hp.—a.c.
177	1—Extra-heavy boring mill, 100 in.	1— 25 hp.—main drive a.c. 1— 5 hp.—rail elevating a.c.
178	1—Tire mill, 100 in.	1— 30 hp.—main drive a.c. 1— 5 hp.—rail elevating a.c.
179	1—800-ton wheel press, 96 in.	1— 15 hp.—a.c.
	1—Portable key-seat miller	
181	1—No. 4 key seating machine.	1— 5 hp.—a.c.
182	1—Radial drill (Universal), 6 ft.	1— 25 hp.—a.c.
183	1—Dbl. floor grinder, 18 in. by 3 in.	1—7½ hp.—a.c.
	1—Babbitt furnace (electric)	
	1—Ring tire heater (electric)	
	1—Loco. valve-setting machine (erecting shop)	1— 25 hp.—a.c.

A convenient portable pneumatic hoist used in the wheel shop

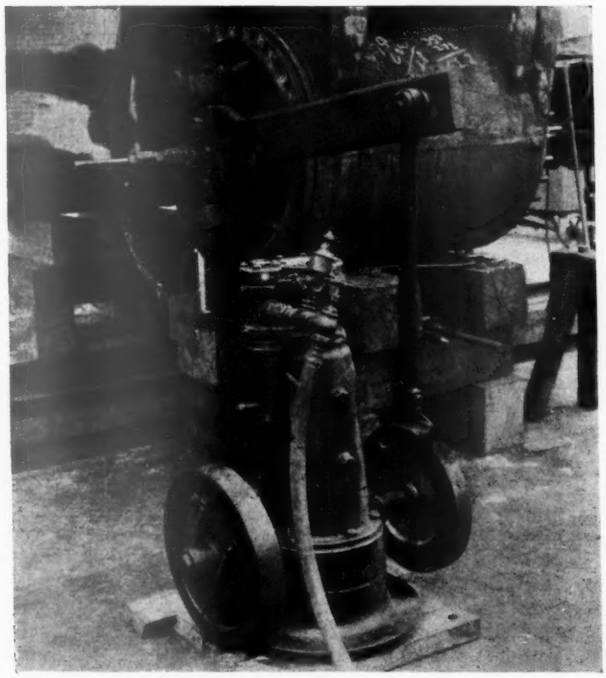
also have the standard drilling tables, can be used for general drilling work when drills are not engaged on frames. The three machines are spaced on centers which will permit overlapping of the arms of the three drills, and are set in a depression which forms a drain for all cutting compound to a common reservoir, from which it is rehandled by a small pump.

One of the illustrations shows an Ingersoll milling machine with a special set of fixtures for holding shoes and wedges and with a gang of high-speed milling cutters for production work.

Many plain surfacing operations, formerly performed on slow moving planers, are now finished on surface

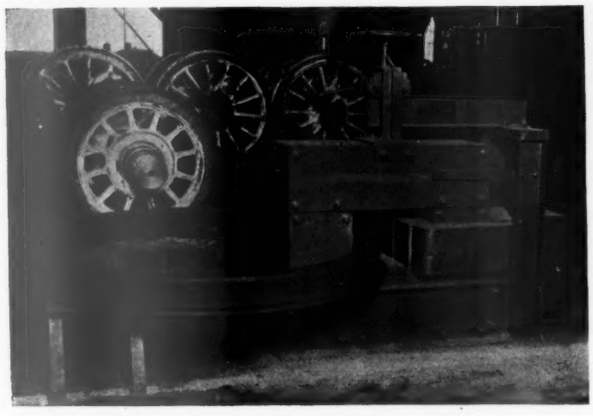
grinding machines. Another of the illustrations shows a good example of how a large number of similar articles can be nested to advantage and handled by means of a magnetic chuck. These machines are equipped with 30-in. grinding-wheels.

A Niles double-head frame slotter incorporates the latest design for operating the slotting head by means of reversing motors through a screw instead of the old style crank arm. The apparent advantage of this type of drive is noticeable in the even smoothness and steadiness of the operations of the machine.



Efficient shop-made device for grinding in cylinder heads

An American electric ring heater, especially designed with capacity for heating locomotive tires, is installed in the machine shop. This machine is successful in heating tires rapidly and uniformly without the noise, gasses and dirt always prevalent when oil is used for this purpose. The machine is also adaptable for any form of ring heating and is used on miscellaneous work.



Electric tire heater which has demonstrated its practicability

A Mahr electric babbit pot, of which there is a number installed in the various shops, is also illustrated. The heating elements are immersed directly in the babbitt, and temperature control is provided to maintain any desired temperature of the babbitt metal.

A typical example of some of the shop-made labor-saving devices to be found in these shops, consists of a small air-operated vertical engine to give a crank motion for grinding in cylinder heads. This is much more efficient and generally satisfactory than reciprocating devices sometimes used for this purpose, which derive their motion primarily from the steam cylinders and heads of air pumps.

(*Other departments will be described next month*).

A Convenient Shop Cabinet

GREASY wooden tool boxes in the shops are always more or less of a fire hazard. For storing small tools and other materials, a cabinet, like the one illustrated, is easily made from light sheet metal and small angle sections. Scrap material may be used and then painted. The drawers are cut out and welded at the corners and small handles are welded on the front end. Partitions may be made in the drawers for various small parts by cutting sheet metal in strips of the proper length and then welding them in crosswise. One-inch angles are used for the framework, supported by sections of strap iron, to which they are welded or bolted with small flat headed bolts.

A cabinet in which tools can be kept in an orderly fashion

The Reader's Page

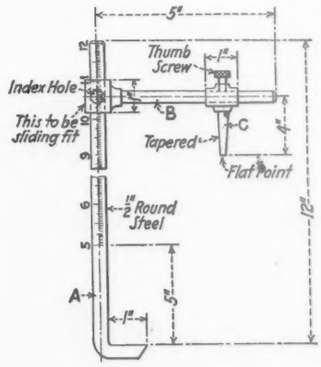
Have You a Question? Ask it
Have You an Opinion? Express it

Gage for Checking Saddle Seats on Driving Boxes

TAMPA, FLA.

TO THE EDITOR:

I am confident that information such as in your article, "Getting Back to Fundamentals," published on page 697 of the December issue of the *Railway Mechanical Engineer*, will find a host of interested readers. I have no doubt but what a great deal of our grief is due to improper distribution of weight due to faulty spring rigging and appurtenances. Such conditions, however, are preventable, but in most cases are created at a time when standards must give way to the demands of service, thus creating a condition that may exist for a great many years.



It is the duty of the main shops to correct such conditions when engines are placed in the shops for repairs. To do so requires adherence to prescribed standards and rigid inspection of all parts. Proper inspection cannot be made, however, without the use of gages to determine just how much and where alterations have been made by wear, stress or wrong practice.

In reading over the above-mentioned article, I noticed that a very simple little gage is used for checking the driving-box spring-saddle seats. I am including a sketch showing a gage used here for this purpose.

In the beginning we decided upon a gage similar to that used by the Chicago & Alton, but found that, owing to variable thickness of driving box flanges and to the fillet in the brass on one end, a true measurement could not be obtained, so we decided on a more flexible gage.

The part *A* is of ½-in. round steel and graduated in 1/32 in. This rod is hooked on the end with the top surface of the hook perpendicular to the center line of the stem. This is for the purpose of getting past the fillet. The length of the rod from the hook to the top is made long enough to take care of all sizes of boxes. Part *B* is a movable perpendicular of sufficient length to extend beyond the greatest flange thickness. The sleeve is drilled to a neat sliding fit. This sleeve has an index hole at its center, which is provided with a small projection with its center on the center line of part *B*. Part *C* is a movable tram point which may be moved out over the spring-saddle seat to the desired place for taking the measurement. It is provided with a thumb screw for making it fast to part *B*.

In use, part *A* is hooked over the center of the crown bearing. Part *B* is slid up over the box flange and part *C* is carried over to and brought up in contact with the saddle seat. Then a direct-reading may be had through the index hole. The gage may then be transferred to the other side of the box.

E. W. O'BRIEN,
Erecting Shop Foreman, Atlantic Coast Line.

What Do You Think?

JOSEPH SMITH has practically issued a challenge to the editor that he ask for constructive ideas on tender tank maintenance. That challenge has been accepted and the request for letters on the subject, brought up by A. T. E. in the December issue, is made herewith. Is there a best way to insure operative tank valves with passages free from obstruction? If you think there is, tell us.

Wanted—Constructive Ideas

LORAIN, OHIO.

TO THE EDITOR:

The remarks concerning the inspection of tank valves by A. T. E. in the December, 1928, issue of the *Railway Mechanical Engineer* were, I must confess, something of a surprise. It is the first time, to my recollection that the tender tank has been discussed in these columns. Now as to the foreman crawling into a tank to make an inspection of the tank valves, it simply isn't being done. The average foreman has enough to do without undertaking the duties of the shop I. C. C. inspector.

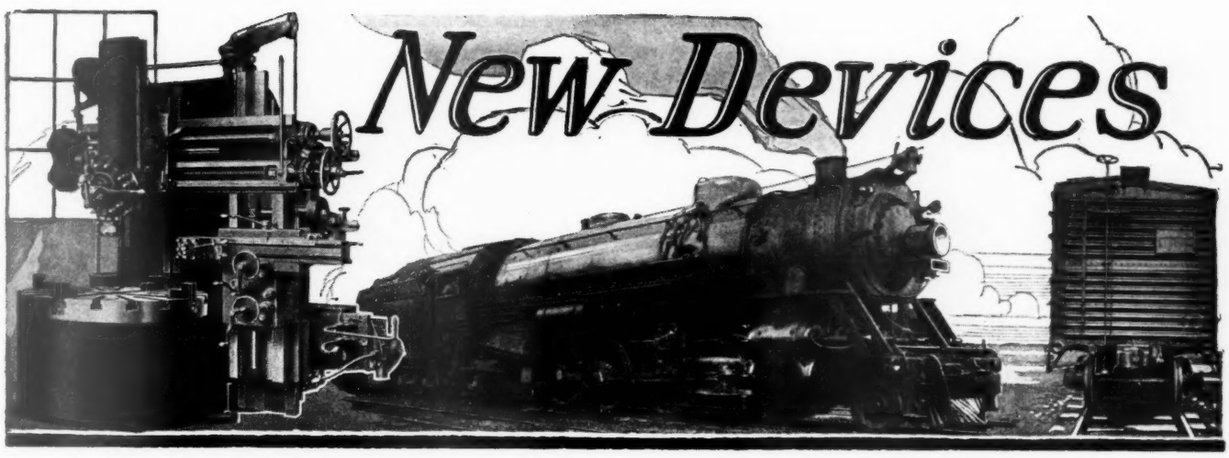
It is generally understood that the shop I. C. C. inspector is held responsible for the reporting of all defects on the engine or tender. Your boiler inspector is held responsible for all defects in the fireboxes, grates, ash pans and operative rigging, cab aprons, cab brackets and running boards, also smoke boxes and appurtenances; all defects in the tank, such as loose bracing or splash plates, defective screening over the tank valves and all leakage, as well as all loose rivets or bolts in the tank frame, must be reported. All this is your boiler inspector's job and responsibility. Your foreman's responsibility is to see that all repairs are made, and here your inspector comes in again. He must see that these repairs are made, before he can sign either Form 1047A or Form 1047B.

The workman also shares in the responsibility, as he must sign the work report or Form 1002, signifying that the repairs have been made.

It is my opinion that there is room for improvement in the way of tender appliances, such as valve screens, bracing, or splash plates. But, why should it be necessary to send a gang into a tank every 30 days for the repairing of broken splash plates, or for the renewal of rivets or bolts in plates, or the repair of tank valve screens.

What do some of your readers think of this problem?

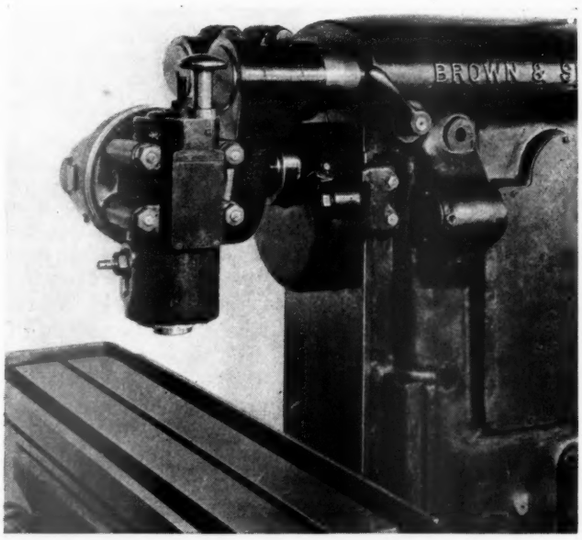
JOSEPH SMITH.



Three Milling-Machine Attachments

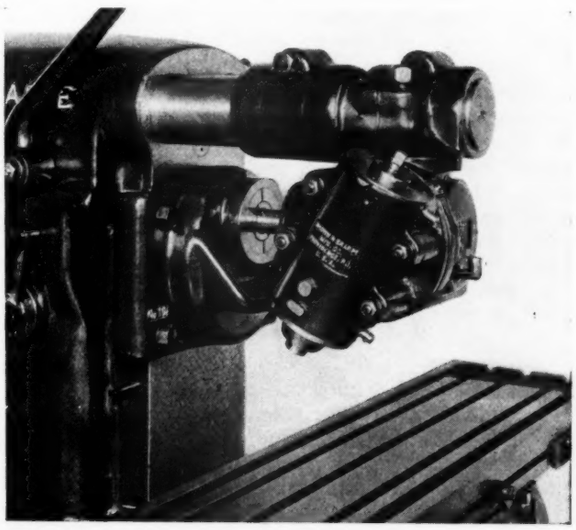
THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently added to its line of milling-machine equipment three vertical spindle attachments especially designed for high-speed work. They are designated as the No. 10 high-speed vertical spindle, the No. 10 high-speed compound vertical spindle and the No. 10 high-speed universal milling attachments. Convenience of control, accuracy of performance and facility of application to constant-speed drives are a few of their major features. Smooth performance and a long life can be expected through the use of anti-friction bearings for the spindle.

The No. 10 high-speed vertical spindle milling attachment is designed particularly for manufacturing jobs where it is desirable to raise the spindle to clear the cutter from the work, to facilitate loading, or for milling keyways, slots and other similar work where it is desired to feed the cutter into the work by hand before engaging the table power feed. The spindle is always in a vertical plane and has a hand adjustment of 2½ in. Adjustable stops regulate the movement of the spindle when milling duplicate pieces.



The No. 10 high-speed vertical spindle milling attachment

The No. 10 high-speed compound vertical spindle milling attachment, with the exception of the high-speed spindle feature, is similar in design and use to the regular Brown & Sharpe compound attachments. It is especially advantageous when it is desired to set the spindle in a plane at right angles to the table for milling angular strips, table ways, etc. With the spindle in this position, the full length of the table travel is available and an ordinary end mill, instead of an angular cutter, can be used for milling the angle.



The No. 10 high-speed compound milling attachment

Full universal movement and consequent usefulness for such work as drilling, milling angular slots and surfaces, cutting racks, milling dies, moulds and other intricate tool work are advantages to be obtained through use of the No. 10 high-speed universal milling attachment. In addition, this attachment is provided with a hand-feed adjustment of 1½ in., which adapts it for angular boring or setting end mills into the work.

All three styles of attachments are securely held in

position by rugged clamps and serve to adapt horizontal-spindle milling machines to work which otherwise could be more advantageously accomplished on a vertical-spindle machine.

Lincoln Safety Push-Button Control

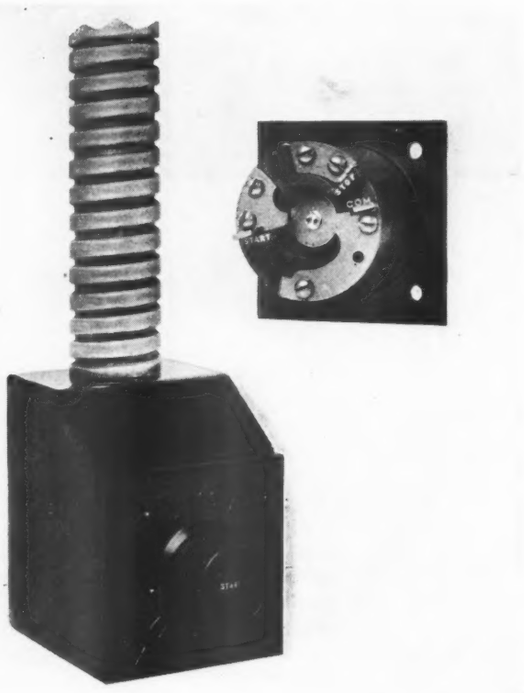
A *SAFETY* type push-button recently developed by the Lincoln research laboratory has been placed on the market by the Lincoln Electric Company, Cleveland, Ohio. Although the device was designed primarily for use with the Lincoln induction starter, it is also available for use with any type of push-button starter.

A ball top start button is contained inside a large stop button which projects over the start button. Thus the stop button protects the start button from accidental contact, as it can only be operated by the tip of a thumb or finger inserted inside the stop button. The stop button can be operated by a finger or the palm of the hand.

The colors of the push-buttons are in accordance with the accepted standard signal colors for controlling railroad, vehicular and pedestrian traffic. The start button is of vivid green moulded Bakelite with the word start in white letters across the ball top face of the button. The surrounding stop button is of brilliant red moulded Bakelite.

The inner mechanism is enclosed in an arc-welded steel box, 2½ in. by 3¼ in. by 2½ in. in size. All insulating parts are of moulded Bakelite. The exterior is jet black with the exception of the push-buttons.

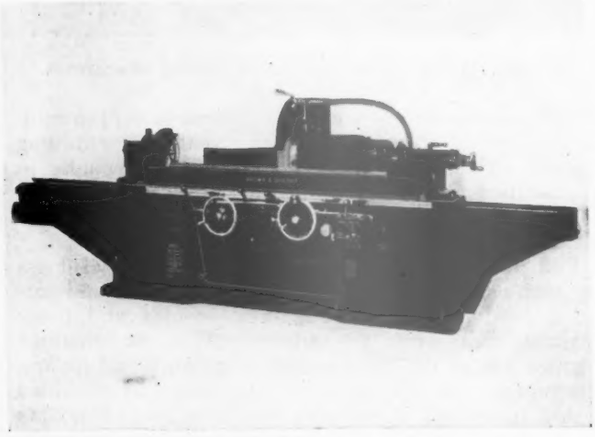
Four screws hold the moulded black Bakelite face plate to the container. By removing these screws, the operating mechanism may be removed from the case for wiring. The binding posts are plainly indicated by white letters on the moulded black Bakelite, thus preventing chance of error in making connections. An opening in top of the steel case ⅞ in. in diameter permits entrance of conduit-enclosed wire at the button. For easy attachment, two holes are located in the back of the case for bolts, rivets or screws.



The Lincoln safety push-button control

No. 35 Plain Grinding Machine

THE Brown & Sharpe Manufacturing Company, Providence, R. I., has recently announced the addition of the No. 35 plain grinding machine to its line of redesigned machines of this type. The No. 35 is similar to the three other machines of this group, except in size. As in the Nos. 30, 32 and 33, which were described on page 356 in the June, 1928, *Railway Mechanical Engineer*, the foot and headstock centers swing material 12 in. in diameter using a 24-in. wheel, and material 6 in. in diameter using a 30-in. wheel, but the centers of the No. 35 will take work 72 in. in length. The floor space dimensions are 74 in. by 189 in.



The Brown & Sharpe No. 35 plain grinding machine

The machine has all of the features of the other three types; namely, an exceptionally wide range of table and work speeds, high table speeds, conveniently grouped controls, changes of speed in the totally independent work driven and table movement that are made through sliding gears and individual levers, a complete system of lubrication of the wheel spindle and all main mechanisms by gravity flow of filtered oil from a reservoir, which is kept flooded by a geared pump, and a choice of overhead countershaft drive by a single pulley or a motor-in-base drive by only one motor.

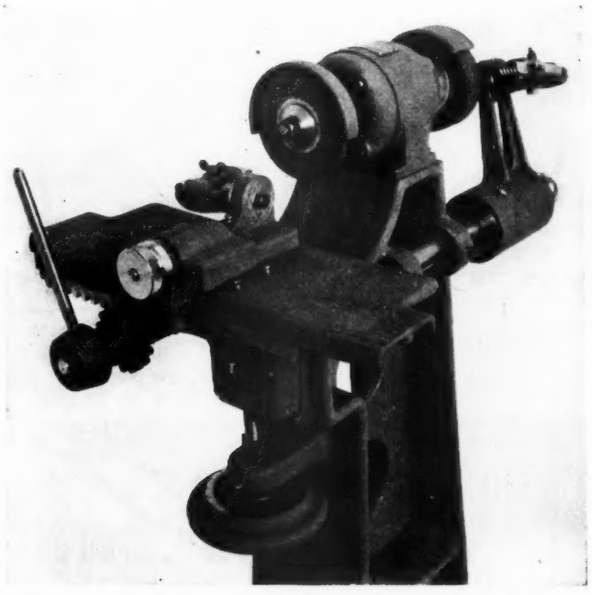
The horsepower required to drive the machine is from 15 to 40, depending upon the work.

A Grinder for Sharpening Die-Head Chasers

TO provide a quicker and more accurate means of sharpening chasers for the J. & L. automatic die heads, the Jones & Lamson Machine Company, Springfield, Vt., has placed on the market a special grinder driven by a ¼-hp. motor, mounted on a pedestal type base that occupies 20-in. by 20-in. floor space. The motor is of ball bearing construction, and operates at 3,450 r.p.m., 110 volts, 60 cycles, unless otherwise specified. The features of the machine are simplicity, accuracy and complete protection of all working parts from emery.

In order to provide for the two distinct grinding operations, the two sides of the grinder are designed to take independent set-ups. On each side are micrometer adjustments reading in thousandths. This includes the vertical elevating screw.

Parts of the regular J. & L. chaser sharpening fixture are employed to provide proper holding of the chasers. This also provides angular adjustment for chamfer on the swinging slide, and angular adjustment for top rake angles on the horizontal slide. The pinion handle for operating the horizontal slide is adjusted for position by withdrawing the pinion from the rack pieces, and adjusting the handle to properly suit the slide travel.

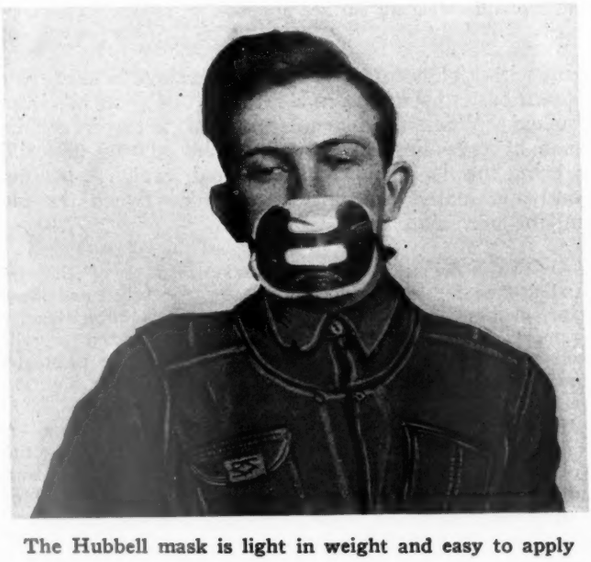


A grinder for sharpening J. & L. automatic die-head chasers

Effective Mask for the Railroad Shop

THERE are many jobs in railway shops with which dust, light gases, or disagreeable odors are associated. Men employed on such jobs are usually provided with protective masks. The Hubbell Mask Company, 527 West One Hundred Twenty-Fifth street, New York, has placed on the market a mask well suited as a protective medium against dust, odors, etc.

The mask is made of a light sheet of soft rolled aluminum cut to fit closely over the mouth and nose. Interchangeable cotton pads held between pieces of gauze cloth are slipped to the mask and the whole held in position over the mouth and nose by a tape or elastic band which can be quickly fastened at the back of the head.



The Hubbell mask is light in weight and easy to apply

Since the mask is made of very soft aluminum, it may be easily bent to fit the face. It does not interfere with the vision, so that the user can wear glasses or goggles. The mask is very light in weight and has no rubber for contact, thereby avoiding sore and inflamed skin. The workmen, therefore, offer little resistance to its use. The pads may be changed every day, or as often as desired, at a nominal cost.

The mask has been endorsed by the Department of Commerce, the Department of Public Health and the National Bureau of Casualty Underwriters.

Welding Gloves Not Affected by Heat

THE Oxweld Acetylene Company, 30 East Forty-second street, New York, has added to its line of accessories for oxy-acetylene welding and cutting, gauntlet gloves of a soft and pliable suede leather, specially treated to prevent heat from affecting them.

A leather strip on the thumb seam and a semi-circular reinforcement on the inside seam adjoining the palm add strength to the glove. The left glove has a leather reinforcement, covering the back between the fingers and gauntlet, for protecting the back of the left hand during cutting operations. A closely fitting gauntlet adequately protects the arms. These gloves will not stiffen or shrivel from exposure to heat or soaking in water.

Steel and Composition Car Flooring

A CAR flooring, which consists of a double truss plate form of steel sub-flooring covered with Masticoke, an asphalt composition wearing surface, has been placed on the market by the Johns-Manville Corporation, 292 Madison avenue, New York.

The truss plate is made of two sheets of No. 22 U. S. S. gage copper-bearing steel, in which staggered rows of oval cones have been pressed. The two sheets are then placed so that they can be riveted or welded together through the tops of the cones. The finished truss plates are coated inside and out with a mineral rubber rust proofing paint for steel, which protects the under side and provides a bond for the surfacing material.

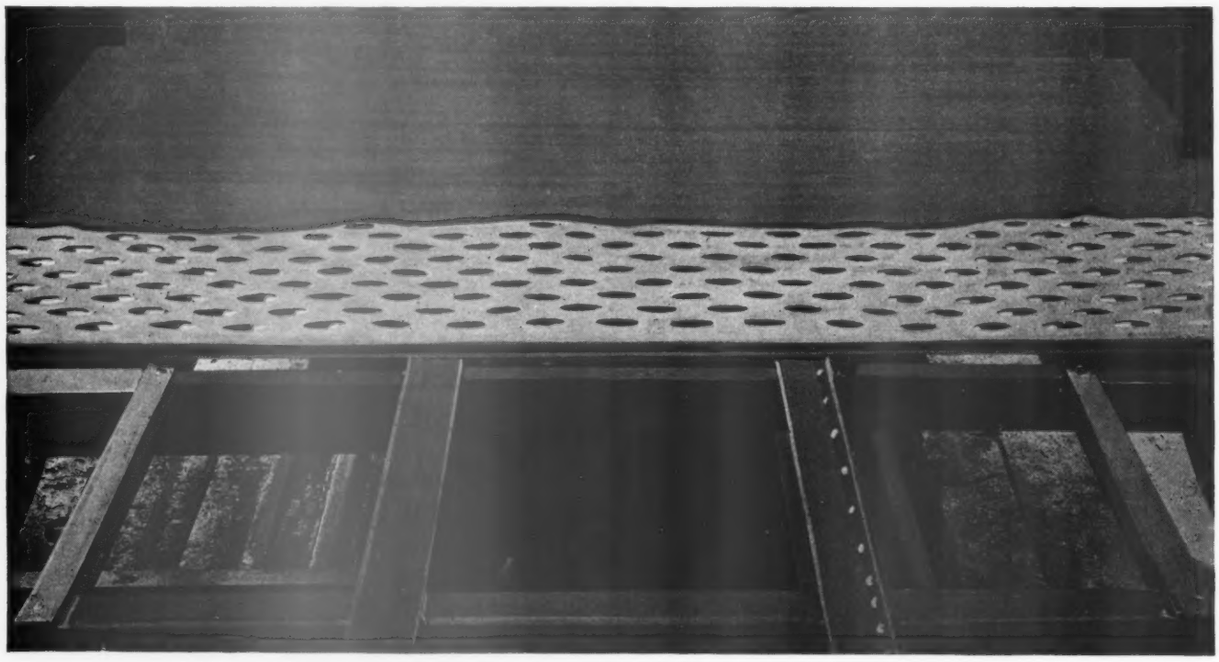
While the double truss plate itself weighs more than other types of steel car sub-flooring, the finished floor weighs much less. The mechanical strength of the plates makes a ⅜-in. or ½-in. wearing surface practicable, whereas other floor structures rely on a thicker wearing surface for strength. A large percentage of the surface of the truss plate is flat. There are no large keyways that must be filled with surfacing material, thereby adding weight.

The truss plate weighs 2.5 lb. per sq. ft. Masticoke weighs 1 lb. per sq. ft. for each ⅛ in. of thickness, giving a total of 5.5 lb. per sq. ft. for a ⅜-in. wearing surface. The plate is made 30 in. wide and in any convenient length up to a maximum of 144 in. The overall thickness of the double truss plate is ⅞ in.

The cones or depressions measure 3½ in. by 1⅜ in. at the base and are arranged in alternate rows of six and seven each, which allows the depressions to overlap slightly. The rows are spaced in 2½ in. centers, both longitudinally and transversely. The distance from the center of the outside row to the edge of the plate is 2 in., leaving a flat margin of 1 5-16 in. for splicing adjoining plates. At the ends, the distance is 3¼ in., leaving a flat margin of 1½ in.

Masticoke provides a flooring that is uniform in texture, pleasing in appearance and thoroughly waterproof. Its asphaltic composition makes it sufficiently plastic to accommodate itself to the weaving of the car frame and minimizes the formation of transverse cracks in the floor. Masticoke is furnished in black, which may be used as the finished floor or as a base coat for the application of a colored mastic wearing surface. Mastic is furnished by the manufacturer in the following colors: Maroon, tan, brown, mahogany, olive green or verde green.

Masticoke and mastic floors are easy to repair. A perfect repair can be made by remelting the original material or substituting new material and sealing the joint with a blow torch. A colored surface is used over a black base to show when a safe limit of wear has been reached. When the black is exposed, a repair can be made by troweling on enough of the colored material to bring the floor back to its original level. A perfect bond and match in color is secured between the old and the new material.



Car underframe showing the truss plate and asphaltic wearing surface applied

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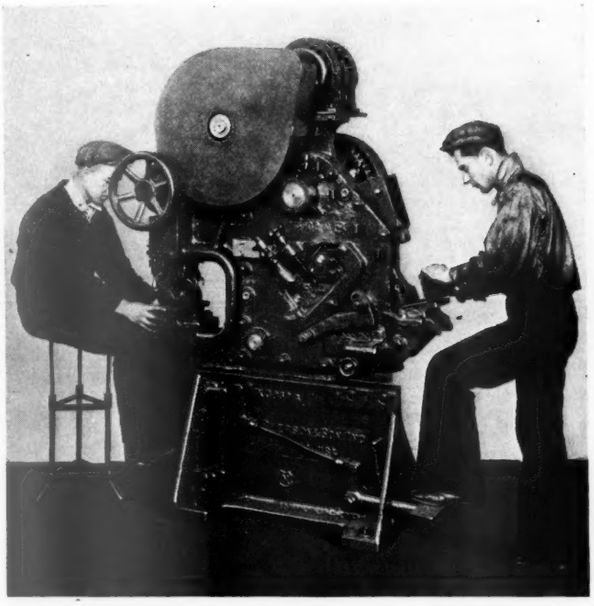
AIR-BRAKE REAMERS.—F-J air brake reamers of the expanding type for hand operation only are described and illustrated in the 48-page catalogue of the Foster-Johnson Reamer Company, Elkhart, Ind. Other tools especially adapted for railroad work also are shown. Several pages of the catalogue contain tables and information of a general nature.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE.—A description of the latest addition to the G & L line, i.e., the No. 50 high power precision horizontal boring, drilling and milling machine,—is given in detail in a six-page folder recently prepared by the Giddings & Lewis Machine Tool Company, Fond du Lac, Wis.

Combination Shear, Punch and Coper

A SMALL model of its combination shear, punch and coper has been placed on the market by the Joseph T. Ryerson & Son, Inc., Chicago, for use in shops handling a varied class of work on the smaller steel sections. The machine handles punching, plate and bar shearing, angle and tee cutting, angle and tee mitering, coping and notching.



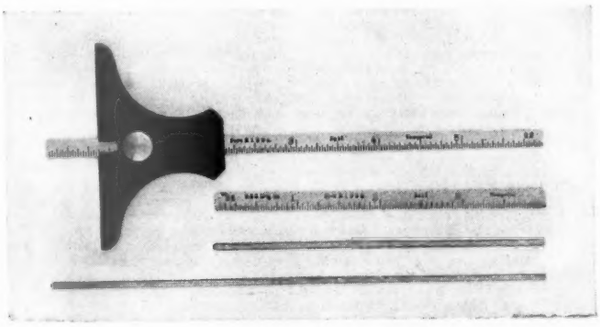
The Ryerson combination shear, punch and coper

The punch has a deep throat and is capable of handling most varieties of structural shapes within its capacity of 11/16 in. through ½-in. material. The operation of the punch is not interfered with by the other units built into the machine. The shearing end of the machine is constructed so that a single slide handles the shearing of angles, bar cutting, plate shearing and coping. The angle shear attachment handles both inside and outside miter cutting as well as straight shearing. The blades in this unit are made in sections for cheap and easy replacement. The bar-cutting blades are located directly below the angle shear blades. These cutters handle both round and square sections and consist of two blades only. The plate-shearing blades are located directly below the bar cutter. They will handle plates of any width or length and up to ⅜ in. in thickness.

The coping device is built at the shear end of the machine and is extended out from the frame and located at a convenient height for operation. This is a built-in feature so that no time is lost in making special set-ups for this class of work. The coping device is regularly furnished in the vee-notch type, but the square notching feature can be provided. Little time is required to change from one to the other. The drive is taken through all-steel gears to alloy-steel eccentric shafts. The clutches are of the two-jaw type, giving the operator a chance to engage the clutch every half revolution of the clutch gear. The main frame of the machine consists of a one-piece alloy steel casting, extending from the base up to the motor shelf. The bearings throughout are bronze bushed and special care has been taken to provide proper lubrication. The working heights of the various attachments have been made such that the base of the machine can be placed directly on the floor, thereby eliminating the necessity of building up a concrete pier in order to bring the machine to a proper working height. This arrangement makes the machine portable.

A Rule Depth Gage for Small Holes

THE Brown & Sharpe Manufacturing Company, Providence, R. I., has placed on the market a rule depth gage with the added feature of a rod. It is so designed that in addition to using either a 4-in. or 6-in. rule, a rod for measuring in small holes can be used. The rod is 5/64 in. in diameter, and will be found a convenient feature when the rules cannot be readily used.



The Brown & Sharpe rule depth gage fitted with a rod for small holes

The blades of the 4-in. size are furnished with No. 10 graduations and of the 6-in. size, with either No. 10 or No. 11 graduation, English measure. The metric-measure blade is graduated in millimeters and half-millimeters. The rod or the rule is conveniently locked at any reading by a turn of the knurled nut on the base. The base is about 2½ in. wide.

The rule depth gage can be furnished either with a 4-in. rule with or without a 4-in. rod, or with a 6-in. rule with or without a 6-in. rod.

BRINNELL MICROSCOPE.—The new Brinell microscope of the projector type is described in detail in Bulletin No. 56 issued by the Paul F. Hermann Company, Keenan Building, Pittsburgh, Pa.

AUTOMATIC LATHE.—The Sundstrand Machine Tool Company, Rockford, Ill., pictorially describes in a 22-page catalogue the design, construction and operation of the Sundstrand automatic lathe.

News of the Month

N. Y. C. Shopmen Granted Higher Pay

FOLLOWING the report of a Board of Arbitrators which was appointed last June and which has held protracted sessions, the shopmen of the New York Central, numbering about 16,500 were last week granted increases of pay amounting to about 40 cents a day. The board, acting under the federal law, filed its decision with the clerk of the United States Court in New York city and the increases are to take effect at once. The road and the employees had agreed to abide by the decision for at least one year. Machinists and the highest classes of workers in each trade, heretofore receiving $6.08 a day are to receive 81 cents an hour, equal to $6.48 a day. In all of the other classifications, the advance is 40 cents a day. The men received about one-third of what they asked for, except that the coach cleaners receive a flat increase of two cents an hour. The neutral members of the board were Julian W. Curtiss, of New York city, and Walter C. Clephane, of Washington, D. C. The record of the proceedings of the board fills 4000 pages.

Professor A. J. Wood Elected President of the A.S.R.E.

PROFESSOR ARTHUR J. WOOD, head of the department of mechanical engineering, The Pennsylvania State College, State College, Pa., has been elected president of the American Society of Refrigerating Engineers for 1929. Professor Wood is the author of many technical papers on railroad mechanical department subjects, and is also the author of the book, Principles of Locomotive Operation. He is a member of a number of engineering and scientific societies, among them being the American Society of Mechanical Engineers, the American Association for the Advancement of Science, Pi Tau Sigma and Sigma Tau. He has been active in the work of the Railroad Division, American Society of Mechanical Engineers, and is a vice-chairman of its Sub-Committee on Professional Service.

Loading Rules Amended

THE SUGGESTIONS for changes in loading rules, made by the Committee on Loading Rules at the regular annual meeting of the American Railway Association, Mechanical Division, at Atlantic City, N. J., June 20-27 inclusive, were ordered submitted to letter ballot, the returns of which are now available. The recommendations of the committee were divided into 31 propositions to amend the following loading rules of the division: Rules 3, 7, 126, 141-A, 201, 201-A, 202, 203, 216, 250-A, 250-B, 255, 260-A, 266, 301, 305-A, 306, 306-A, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 521, 561, 562, 563, 564 and 565. All of these propositions received the necessary two-thirds majority vote and have been approved by the American Railway Association, effective January 1, 1929.

THE AMERICAN RAILWAY ASSOCIATION has recently issued circular No. 2739 containing the report of the Joint Committee on Utilization of Locomotives and Conservation of Fuel. This report gives in a comprehensive manner a comparison of the accumulative totals and averages of operating statistics for the first nine months of 1928, compared with the same period of 1927 for Class I carriers. The trends in volumes and performance are shown and the circular contains information of value for anyone interested in the utilization of power and saving of fuel.

THE SUPREME COURT OF THE UNITED STATES, in a decision handed down on January 2, affirmed the decree of the district court for the northern district of Oklahoma granting a permanent injunction against an order of the Oklahoma Corporation Commission which had attempted to restrain the St. Louis-San Francisco from moving its shops and division point from Sapulpa to West Tulsa.

Clubs and Associations

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its next annual meeting at the Chalfonte-Haddon Hall at Atlantic City, N. J., on June 24-28.

The following list gives name of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—T. L. Burton, 165 Broadway, New York. Next meeting, April 30-May 3, 1929, at Stevens Hotel, Chicago.

AMERICAN RAILWAY ASSOCIATION DIVISION V—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Annual meeting June, 1929, at Los Angeles, Cal.

DIVISION V—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting, September, 1929.

DIVISION VI—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York. Annual meeting June 19, 20, and 21, 1929, at the St. Francis Hotel, San Francisco, Cal.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet avenue, Chicago. Next meeting, September 11-14, 1929, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 7016 Euclid Ave., Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth street, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charon St., Montreal, Que. Regular meetings, second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—G. K. Oliver, Chicago & Alton, Chicago, Ill. Regular meeting second Monday in each month, except June, July and August, Great Northern Hotel, Chicago. Next meeting, February 11. Discussion of the new A.R.A. Rules.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—A. J. Walsh, 5874 Plymouth Apt. 18, St. Louis, Mo. Regular meeting first Tuesday in each month, except June, July and August, at Broadview Hotel, East St. Louis, Ill.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles, Cal. Meeting second Friday of each month in the Pacific Electric Club building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York. Regular meetings second Tuesday each month, except June, July and August, at Hotel Statler, Buffalo. Next meeting February 14 at 8 p.m. A paper in the interest of transportation, with film picture, will be presented by W. H. Sanford, of the American Car & Foundry Company. Entertainment. Musical by the University Quartette of Buffalo.

CHIEF INTERCHANGE CAR INSPECTORS AND CAR FOREMEN'S ASSOCIATION.—See Master Car Builders' and Supervisors Assn.

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 3328 Beekman St., Cincinnati. Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.— F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meeting first Monday each month, except July, August and September at Hotel Hollenden, East Sixth and Superior Ave.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next meeting, August 20-22, 1929, Fort Shelby Hotel, Detroit.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—L. G. Plant, Railway Exchange, 80 E. Jackson Boulevard, Chicago. 1929 Annual meeting Hotel Sherman, Chicago, May 7-10, inclusive.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash Ave., Winona, Minn.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3212 Delachaise street, New Orleans, La. Meetings third Thursday in each month.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St.,

New York. Annual meeting May 21-24, 1929, Hotel Biltmore, Atlanta, Ga.

MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—A. S. Sternberg, master car builder, Belt Railway of Chicago, Chicago.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in each month, excepting June, July, August and September, Copley-Plaza Hotel, Boston. Next meeting February 12. Paper on Progress in Track and Roadbed Construction and Maintenance will be presented by J. V. Neubert, chief engineer, maintenance of way, New York Central.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York. Next meeting February 15 at 8 p.m. Address by A. G. Pack, chief inspector, Interstate Commerce Commission. D. & H. quartette.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings, second Tuesday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR DEPARTMENT OFFICERS' ASSOCIATION.—See Master Car Builders' and Supervisors' Association.

RAILWAY CLUB OF GREENVILLE.— Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meeting third Thursday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting third Thursday in November, Ansley Hotel, Atlanta, Ga.

SOUTHWEST MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—See Master Car Builders' & Supervisors' Association.

TRAVELING ENGINEER'S ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 189 West Madison St., Chicago. Regular meetings, third Monday in each month, except June, July and August.

Supply Trade Notes

R. W. OTT has been appointed sales manager of the Oesterlein Machine Company, Cincinnati, Ohio.

THE TIMKEN STEEL & TUBE COMPANY, Canton, Ohio, has completed construction work on its new mill and has started on a full capacity production schedule.

THE DUFF MANUFACTURING COMPANY, Pittsburgh, Pa., has purchased A. O. Norton, Inc., Moline, Ill. The new company will be known as the Duff-Norton Mfg. Company.

THE PHILADELPHIA OFFICE of the Brown & Sharpe Mfg. Company, Providence, R. I. has been removed to 1102 Elverson building, Broad and Callowhill streets.

ANDREW WELLS ROBERTSON has been elected chairman of the board of directors of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

ARCHIE H. DICK, who has been in the service of the American Locomotive Company and its subsidiary, the American Locomotive Sales Corporation, for the last 25 years has resigned as South American representative.

DR. HAIG SOLAKIAN, for several years a member of the metallurgical staff of the National Bureau of Standards, has resigned to become chief metallurgist of the Geometric Tool Company, New Haven, Conn.

R. J. SCANLON, formerly chief of the materials inspection and testing department of the T. E. Murray Company, New York, has been appointed sales engineer of the Walworth Company, with headquarters at New York.

THE UNIVERSAL PACKING AND SERVICE COMPANY, Chicago, has changed its name to the Spring Packing Corporation and has moved its executive and sales offices to 310 S. Michigan avenue. James S. Hearon has been appointed vice-president and secretary of the new corporation.

JUDD W. SPRAY has been appointed vice-president and general sales manager of the Timken Roller Bearing Company, Canton, Ohio. Mr. Spray has been general sales manager of the company since 1926 and previous to that he had been sales manager of the automotive division of the company in Detroit for several years.

W. E. DEAN, assistant chief engineer of the Westinghouse Air Brake Company, at Wilmerding, Pa., has been appointed chief engineer of the Westinghouse Air Brake Company of Australasia, Ltd., with headquarters at Sydney, New South Wales.

THE HEAT TRANSFER PRODUCTS, INC., has become affiliated with the American Locomotive Company. All manufacturing will be done in the plants of the American Locomotive Company. George T. Jacocks remains as manager of Heat Transfer Products, Inc., and the company name will be retained. The office of the company is at 30 Church street, New York.

ROBERT M. GATES, manager of the industrial department of The Superheater Company, New York, has been elected vice-president. Mr. Gates affiliated himself with the Superheater Company in 1922 and has since been actively engaged in directing the engineering and sales of Elesco superheaters for stationary power plants and special pipe coils for the oil and other industries. Mr. Gates is a native of Iowa. Following his graduation from the School of Engineering, Purdue University, in 1907, he served as a special apprentice on the Pennsylvania and with the Browning Engineering Company of Cleveland, Ohio, until 1910. The next few years he had his own engineering office in Cleveland and later was associated with the Thew Shovel Company, Lorain, Ohio, following which he was manager of the Lakewood Engineering Company, Cleveland. He has taken a prominent part in the activities of the American Society of Mechanical Engineers. For the past two years he has been Chairman of the Committee on Meetings and Programs, and at the last general election he was made a member of the Council of that society.

Robert M. Gates

THE FOLLOWING TRANSFERS and promotions in the general railroad and government department of the Johns-Manville Corporation have been made: Carl S. Clingman of the St. Louis district, has been promoted and transferred to New York general headquarters, as assistant general sales manager of the railroad and government department; A. C. Pickett, special railroad representative, has been transferred from Houston, Tex., to the St. Louis district, vice Mr. Clingman; D. B. Bell, special representative, has been transferred from St. Louis district to Houston, Tex., vice Mr. Pickett, and Elliott Fairback has joined the staff as special representative in the St. Louis district vice Mr. Bell.

THE MILBURN SALES CORPORATION and the Milburn Paint Spray Corporation were incorporated on December 31, 1928, under the laws of the State of Maryland, to carry on the sale of a number of the products manufactured by The Alexander Milburn Company, Baltimore, Md. Alexander F. Jenkins, is president and treasurer, and Edward P. Boyer is vice-president, of both companies, Louis J. Herzog, is secretary of the Milburn Sales Corporation and Robert M. Zimmermann is secretary of the Milburn Paint Spray Corporation.

ALEXANDER M. HAMILTON has been appointed foreign sales manager of the American Locomotive Sales Corporation, in charge of foreign sales of the American Locomotive Company, with headquarters at New York. After graduating from Cornell in 1909, Mr. Hamilton served as special apprentice with the Erie. He was later employed in the engineering department of the Westinghouse Electric & Manufacturing Company, at East Pittsburgh, Pa., for about one year, after which he entered the employ of the American Locomotive Company at Schenectady, serving in the shops, estimating and engineering departments. In 1915 he went to Russia as technical representative of the American Locomotive Company returning via Siberia and the Pacific in 1918. He served for a few months in San Francisco as district sales manager on the Pacific Coast, and then entered the U. S. Field Artillery. After the Armistice he returned to the American Locomotive Sales Corporation as European representative, with headquarters in Paris, from which post he was transferred to New York in 1921 as assistant vice-president.

A. M. Hamilton

ARTHUR E. BLACKWOOD, first vice-president of the Sullivan Machinery Company, Chicago, has been elected president to succeed Frederick K. Copeland, deceased. Mr. Blackwood entered the employ of the Sullivan Machinery Company in 1899, shortly after graduating from the Toronto University as a mechanical and electrical engineer. Later he was appointed manager of the eastern sales department with headquarters in New York. In 1922 he was elected first vice-president in charge of finances, with headquarters at Chicago, where he remained until his recent appointment.

T. H. WILLIAMS, who has been appointed manager of railway sales for the Electro-Chemical Engineering Corporation, Chicago, was born at Beloit, Kan. He served a machinist apprenticeship on the Chicago, Milwaukee & St. Paul and at the same time completed two engineering courses from the International Correspondence Schools, after which he spent five years as air brake and mechanical instructor on the instruction cars owned and operated by the International Correspondence Schools. He re-entered railroad service in 1905 with the Southern at Knoxville, Tenn., as roundhouse foreman and served as general foreman, division foreman and master mechanic until 1910 when he went to the International Great Northern as master mechanic. In January, 1914, he resigned to become mechanical expert for the Buda Company. Two years later he entered the sales force of the Chicago Cleveland Car Roofing Company and on November 1, 1927, left to join the sales organization of the Electric Service Supplies Company, where he remained until his recent appointment.

T. H. Williams

THE SHEPARD ELECTRIC CRANE & HOIST COMPANY, including its Sprague division, and the Niles Crane Corporation have been combined under the name of Shepard-Niles Crane & Hoist Corporation. The Shepard plant at Montour Falls, N. Y., and the Niles plant at Philadelphia, Pa., will be continued in operation. The main office will be at Montour Falls. The officers of the new corporation are Colonel Edward A. Deeds, chairman of the board; S. G. H. Turner, chairman of the executive committee; Frank A. Hatch, president; Sydney Buckley, first vice-president; James A. Shepard, vice-president, and Robert T. Turner, vice-president. To the board of directors will also be added Colonel Leonard S. Horner, president, and Charles K. Seymour, vice-president of the Niles-Bement-Pond Company. The three divisions of the new company will operate as the Shepard division, the Niles division and the Sprague division.

P. N. GUTHRIE, JR., has been appointed vice-president of the Reading Iron Company, and the general sales offices of the company will be transferred from Reading, Pa., to 30 Church Street, New York City. Mr. Guthrie will have charge of sales and H. F. Mattern will continue as general sales manager. Mr. Guthrie was born in Pittsburgh in 1876, where he attended public and private schools. In 1892 he took a position with Park Brothers & Company, Black Diamond Steel Works, and served until March, 1894, in several minor capacities. From March, 1894, to February 1, 1900, Mr. Guthrie was with the Philadelphia Company, of Pittsburgh, as an inspector of pipe made by mills in the Pittsburgh district and was superintendent of the pipe line and drilling work done by contractors for the company in West Virginia, Ohio, Kentucky, Tennessee and Pennsylvania. He served from 1900 to 1902 as general manager of the Hornell Gas Light Company, Hornellsville, N. Y., and then to 1906 as general manager of the Chemung County Gas Company, Elmira, N. Y. On February 1, 1906, he returned to Pittsburgh and became representative of Longmead Iron Company, manufacturers of wrought iron pipe, and in 1907 was transferred to Philadelphia as general sales manager of that company. In December, 1909, he resigned to become New York representative of the South Chester Tube Company, with which company he has served continuously to the present time, except during the war period, August, 1917, to December, 1918, when he was assistant director, Bureau of Oil Well Supplies, Fuel Administration, Oil Division.

P. N. Guthrie, Jr.

THE AMERICAN STEEL FOUNDRIES, through a subsidiary company which will be known as the General Steel Castings Corporation in which it is understood the Baldwin Locomotive Works and American Locomotive Company will be interested, will build a plant for the manufacture of large steel castings, on approximately 100 acres of land adjoining Baldwin Locomotive Works, at Eddystone, Pa. While no announcement has been made as to the official personnel of the new company, it is assumed it will be headed by R. P. Lamont, president of the American Steel Foundries.

THE CINCINNATI CAR CORPORATION, Cincinnati, Ohio, now makes a complete line of industrial locomotives in gasoline, gasoline-electric, Diesel, electric trolley and storage battery types. These locomotives will be furnished in a variety of sizes from small two and three ton units up to 50-ton, or larger, and in various track gages, suitable for handling either small or large industrial cars, as well as for switching railroad cars.

Personal Mention

General

C. W. SMITH, inspector of shop standards of the Union Pacific, has been promoted to special representative of the general superintendent of motive power and machinery of the system, with headquarters at Omaha, Neb.

M. C. HABER, engineer of road tests of the Union Pacific, has been promoted to special representative of the general superintendent of motive power and machinery of the system, with headquarters at Omaha, Neb.

A. J. HARNER, lubrication engineer of the Union Pacific, has been promoted to special representative of the general superintendent of motive power and machinery of the system, with headquarters at Omaha, Neb.

ARTHUR H. FETTERS, mechanical engineer of the Union Pacific unit of that system, has been promoted to general mechanical engineer of the Union Pacific system, with headquarters as before at Omaha, Neb. Mr. Fetters has been in the service of the Union Pacific for nearly 28 years. He was born at Philadelphia, Pa., on July 14, 1871, and graduated from Lehigh University in mechanical engineering in 1892. For the following seven years Mr. Fetters was connected with the Baldwin Locomotive Works, entering railway service in 1899 as chief draftsman in the mechanical department of the Erie. From April to August, 1901, he again served with the Baldwin Locomotive Works, then being appointed chief draftsman in the mechanical department of the Union Pacific. Later he was advanced to assistant mechanical engineer and in 1904 to mechanical engineer of the Union Pacific system.

Arthur H. Fetters

J. K. PETERS, assistant to the mechanical engineer of the Union Pacific, has been promoted to special representative of the general superintendent of motive power and machinery of the system, with headquarters at Omaha, Neb.

HOWARD C. JONES has been appointed supervisor of motor car operation of the Chesapeake & Ohio, with headquarters at Richmond, Va.

H. L. HARPER, assistant master mechanic of the Lehigh & New England, with headquarters at Pen Argyl, Pa., has been appointed mechanical inspector, with headquarters at the same point.

C. Y. THOMAS, night enginehouse foreman of the Kansas City Southern at Port Arthur, Tex., has been appointed chief locomotive inspector, with jurisdiction over the system and with headquarters at Pittsburg, Kan., reporting to the general manager.

JAMES H. CONNOR, special representative of the superintendent of motive power and machinery of the Union Pacific unit, has been promoted to special representative of the general superintendent of motive power and machinery of the system, with headquarters at Omaha.

Master Mechanics and Road Foremen

R. V. CARLETON, division master mechanic of the Canadian Pacific at Schreiber, Ont., has been transferred to the Ottawa division, succeeding J. S. Allen.

E. BOWIE has been appointed district master mechanic of the Saskatchewan district of the Canadian Pacific, with headquarters at Moose Jaw, Sask.

F. T. HUSTON, master mechanic of the Pennsylvania at Dennison, Ohio, has been transferred to the Panhandle and Wheeling divisions, with headquarters at Pittsburgh, Pa.

R. C. CROSS has been appointed master mechanic of the Third District of the New York Central, with headquarters at Collinwood, Ohio. Mr. Cross was formerly enginehouse foreman at Coalburg, Ohio.

HUGH RONALDS, road foreman of engines of the Lehigh & New England has been appointed assistant master mechanic, with headquarters as before at Pen Argyl, Pa., succeeding H. L. Harper.

J. S. ALLEN, master mechanic of the Ottawa division of the Canadian Pacific, has been appointed master mechanic of the Montreal terminals, succeeding J. M. Burke, transferred.

J. M. BURKE, division master mechanic of the Canadian Pacific with headquarters at Montreal, Que., has been transferred in the same capacity to London, Ont., succeeding H. M. Smith, transferred.

J. S. RICHARDS, master mechanic of the Pennsylvania at Mingo Junction (Steubenville), Ohio, has been appointed assistant master mechanic of the Wheeling division, with the same headquarters and jurisdiction, which includes the Steubenville-Weirton district of the Panhandle.

W. J. RENIX, master mechanic of the British Columbia district of the Canadian Pacific with headquarters at Vancouver, B. C., has been transferred to the Manitoba district with headquarters at Winnipeg, Man., succeeding F. R. Pennefather who has retired under the provisions of the company's retirement plan.

Shop and Enginehouse

S. I. KUHN has been appointed night general foreman of the New York Central, with headquarters at Collinwood, Ohio.

C. I. BARCLAY has been appointed assistant general foreman of the New York Central, with headquarters at Collinwood, Ohio.

G. M. ISREAL, assistant day enginehouse foreman of the Chicago, Rock Island & Pacific at Little Rock, Ark., has been promoted to the position of night enginehouse foreman.

W. A. WERLEY, night enginehouse foreman of the Chicago, Rock Island & Pacific at Little Rock, Ark., has been promoted to the position of day enginehouse foreman.

C. A. WELCH, enginehouse foreman of the Chicago, Rock Island & Pacific at Little Rock, Ark., has been promoted to the position of general locomotive foreman.

D. C. NICKELL, erecting gang foreman of the Union Pacific at Omaha, Neb., has been promoted to the position of general foreman, with headquarters at Cheyenne, Wyo.

J. H. BRUNKHORST, assistant shop superintendent of the Missouri-Kansas-Texas at Sedalia, Mo., has been promoted to shop superintendent at that point succeeding William Walker, who retired from active service on January 1.

W. A. LARRICK, at his own request, has been appointed road foreman of engines of the Third District of the New York Central, with headquarters at Collinwood, Ohio. Mr. Larrick was transferred from the position of master mechanic.

OTTO JABELMANN, superintendent of shops of the Union Pacific at Cheyenne, Wyo., since 1925, has been appointed superintendent of shops, with headquarters at Omaha, Neb. Mr. Jabelmann was born July 24, 1890, at Cheyenne, Wyo., his education being received in the common schools of that city and at the University of Michigan, where he took a three-year course from September, 1910, to June, 1913. Except for a short period, from May to August, 1917, when he served as machinist for the Southern Pacific at San Francisco, Cal., Mr. Jabelmann's employment has been solely with the Union Pacific. He entered the service of the latter road, September 22, 1906, as a caller at Cheyenne, Wyo., becoming an apprentice at that point, June 13, 1907; machinist helper, April 18, 1910; machinist, June 16, 1913; assistant enginehouse foreman, April 1, 1914; general foreman, Laramie, Wyo., April 11, 1916; machinist, Cheyenne, April 20, 1916; enginehouse foreman, Cheyenne, August 19, 1916; machinist, North Platte, Neb., August 24, 1917; enginehouse foreman, Cheyenne, December 1, 1917; district foreman, Cheyenne, March 1, 1920; enginehouse foreman, Cheyenne, July 26, 1920; temporary enginehouse foreman, Cheyenne, July 1, 1922; day enginehouse foreman, Cheyenne, December 1, 1922; district foreman, Cheyenne, September 15, 1923; superintendent shops, Cheyenne, August 1, 1925. Mr. Jabelmann was granted a leave of absence November 30, 1927, returning February 2, 1928 as superintendent of shops at Cheyenne.

O. Jabelmann

R. H. FASEN, general foreman of shops of the Union Pacific at Cheyenne, Wyo., has been appointed superintendent of shops, with headquarters at Cheyenne. Mr. Fasen was born November 28, 1871, in Germany, his education being received in the common schools of that country. From 1890 to 1895, Mr. Fasen served as a machinist apprentice in the St. Cloud Iron Works, St. Cloud, Minn., and his subsequent experience other than on the Union Pacific included two years as machinist and foreman for the American Locomotive Works at Pittsburgh, Pa., one year as foreman for the National Tube Company at Wheeling, W. Va., one year as master mechanic for the Blooming Converting Mills at Wheeling, three years as millwright for the Laramie Rolling Mills and three years as foreman and master mechanic for the L. H. P. & P. Mr. Fasen entered the service of the Union Pacific as a machinist at Cheyenne in October, 1899, becoming machine shop foreman, Cheyenne, June 1, 1909; machinist, Laramie, Wyo., December 7, 1914; enginehouse foreman, Cheyenne, January 13, 1915; general foreman, Cheyenne, March 1, 1915; general enginehouse foreman, Cheyenne, November 1, 1917; general foreman, Cheyenne, July 1, 1919; acting superintendent of shops, November 20, 1927; and general foreman, Cheyenne, February 2, 1928.

Car Department

CLIFFORD RHODES has been appointed supervisor of car repairs of the western District of the Erie, with headquarters at Cleveland, Ohio.

DREW MATLOCK has been appointed general car foreman of the Lehigh & New England with headquarters at Pen Argyl, Pa., succeeding J. H. Ford, deceased.

LINUS C. FITZGERALD has been appointed chief A. R. A. inspector of the Erie, in charge of all A. R. A. checking and billing, with headquarters at Hornell, N. Y.

F. W. STEVENS, general car foreman of the Missouri-Kansas-Texas at San Antonio, Tex., has been promoted to assistant shop superintendent at Sedalia, replacing J. H. Brunkhorst.

L. R. CENTER, assistant car foreman of the Missouri- Kansas-Texas at San Antonio, has been promoted to general car foreman at that point to succeed F. W. Stevens.

EDWARD PENDERGAST, general car foreman on the Southern Pacific at West Oakland, Cal., has been promoted to master car repairer of the Sacramento division, with headquarters at Sacramento, Cal., succeeding Andrew J. Gilson, who retired from active service on November 1.

Obituary

W. L. TRACY, formerly superintendent of the shops of the Lehigh Valley at Sayre, Pa., died at his home in Shavertown, Pa., on December 23, at the age of 70. Mr. Tracy was born in Wyalusing, Pa., and entered railroad service as a machinist on the Lehigh Valley at Wilkes-Barre, Pa. He subsequently went to the Southern, where he was general foreman in the shops at Alexandria, Va., being promoted later to the position of master mechanic at Atlanta, Ga. In 1905, he became master mechanic of the Louisville & Nashville at South Louisville, Ky., where he organized the large shops, employing 3,200 men. In 1908, he went to the Missouri Pacific as assistant superintendent of motive power. On the opening of the Sayre shops, he returned to the Lehigh Valley. He retired from the superintendency of the shops in 1921 but for some time after was engaged in special service for the Lehigh Valley.

CHARLES H. CORY, formerly for 19 years superintendent of motive power of the Cincinnati, Hamilton & Dayton, died from uremic poisoning at his home at Lima, Ohio, on November 3, at the age of 88 years. Mr. Cory, at the time of his retirement in 1905 had been in railway service for 49 years. He was born in Morris County, N. J., and entered railway service in 1856 as an apprentice in the Cook Locomotive Works at Paterson, N. J. From 1862 to 1886 he served successively as foreman and master mechanic of the Illinois Central; master mechanic of the Cairo & Vincennes (now part of the Wabash), of the Iowa Central (now part of the Minneapolis & St. Louis), and of the Scioto Valley (now part of the Norfolk & Western); division superintendent of construction on the New York, Chicago & St. Louis, and superintendent and master mechanic of the Boston, Hoosac Tunnel & Western (now part of the Boston & Maine). Mr. Cory served as superintendent of motive power of the C., H. & D. from 1886 until its consolidation with the Baltimore & Ohio in 1905. Since his retirement he had devoted his energies to business interests at Lima.